POWER

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STEPPING OUT

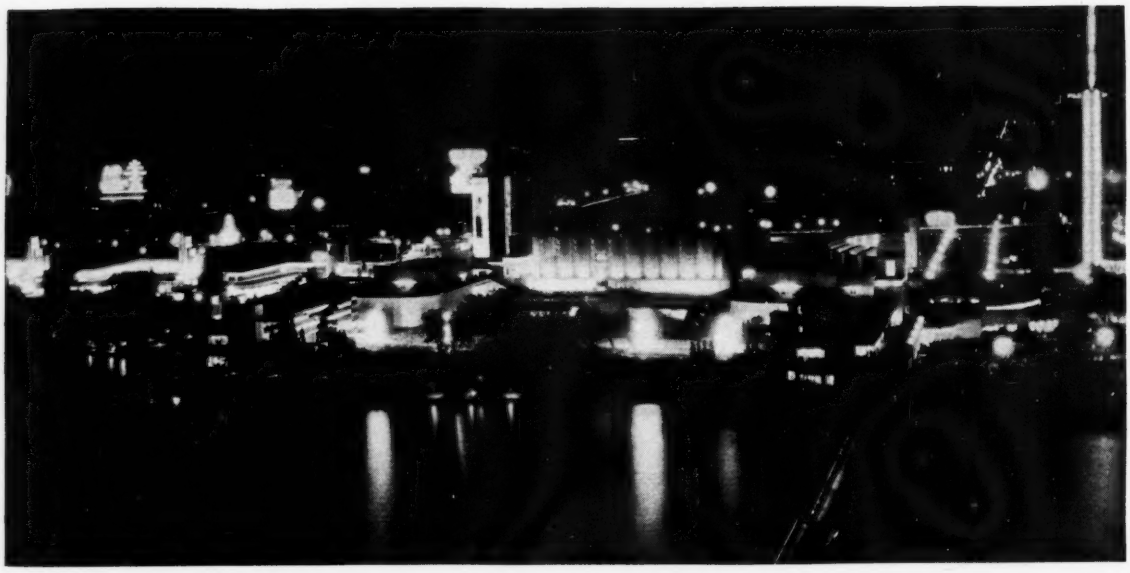
• *Chicago had the courage* to act, and now the busy city is BUSY. Hotels are jammed. From all directions people pour in by train, auto, bus and plane. They stream out along the Lake front into the Century of Progress Exposition, more than 100,000 a day, day after day.

• *Science by the mile* and all dressed up. Vivid buildings. At night dazzling colors, fireworks, music beside the lagoon. Steamboat rides on Lake Michigan. Moonlight and pretzels. Within this genial shell, Chicago stages the world's greatest show of scientific achievement.

• *Thousands of engineers* joined the throng on June 25—twenty societies, seventy sessions, two hundred papers, a solid week. Engineering's greatest week, and on June 28 its greatest day.

• *Down in Washington* is another show, less sparkling, but even more important. Under the Industrial Recovery Act, America moves forward—in step with leadership—to make its own daily bread instead of waiting for it to fall from the skies. Greatest achievement in government since the War.

• *Chicago, Washington and America* have learned what the engineers who assembled in Chicago have always known: Things are done by doing.



One-fifth of the 3-mi. Exposition on the mainland; Hall of Science in center

CENTURY'S ENGINEERING PROGRESS

Scientists, engineers, architects, artists, artisans, industrialists and financiers, combine efforts to put on the most spectacular show of the ages

"HE CAME to scoff and remained to pray"—thus ran the old story and thus will run the story of many a visitor to Chicago's Century of Progress Exposition this summer. Suppose you enter the Exposition gate by day, after running a gauntlet of souvenir hawkers. Inside, a loud speaker greets you with music more or less sweet, according to your taste in such matters. And right here, if you have been looking for architectural grandeur, you may be in for a shock. Except for the looming steel towers of the "skyride," tallest structures west of Manhattan, nothing visible from the gate rises to notable height. The buildings resemble eccentric cardboard boxes painted in the glaring colors of the nursery—lemon yellow, blood red, morgue blue and Paris green, to invent a few descriptive terms. These gaudy colors and their strange combinations are likely to worry the conservative visitor even after he is told that the famous Joseph Urban selected them. At night it is a different story.

More of that later; we are talking of first impressions. Take the sightseeing bus trip through the grounds and make your first revision. The Exposition will still seem a bit gaudy (except for the beautiful Belgian village, the Chinese temple and a few other replicas), but it begins to impress you by its mere size. Here is something *big*, at least, you will say. From end to end, in a bee line, the Exposition stretches three miles along the shore of Lake Michigan with an additional mile or more on the island enclosing the lagoons.

With your mind pretty well made up that this show in Chicago's front yard is not so long on quality as on quantity spend the rest of the day "doing" the Hall of Science, the Electrical Building or the Transportation Building. When you come out you will be ready to wire your friends to take the next train to Chicago. "If this is a sample, bring on the cake."

Never before in this country have the marvels of pure and applied science been presented so completely and beautifully.

To attempt to picture the "World's Fair" by mentioning a few of these exhibits is like showing a man three or four tropical plants, then asking him to use his own imagination to reconstruct the Amazon jungle. It can't be done in this space, or in ten times this space. Nevertheless, here goes for a try!

They say that a visitor walking past every exhibit at the Fair would travel 83 miles. Anybody who has tried it will agree. The following samples, selected mainly from those related to power, probably come to about one per cent of the total. Yet far more than half of the entire Exposition displays scientific achievement. This is proper, In no other field has comparable progress been made in the century which this show celebrates.

Thomas Edison is the only man (except Buddha, who has a Chinese temple) to rate a building of his own. As part of the electrical group on Northerly Island this building houses models and vivid charts summing up the life and achievements of the great inventor.

Many will vote this electrical group, with its great buildings devoted to Communications and Electricity, the crowning achievement of the Exposition. Others will choose the Hall of Science, Transportation or General Motors. All are wonderful.

Outstanding electrical-group exhibits are: Electric Light and Power Industry, General Electric, Westinghouse and Bell Telephone. These four alone are worth a trip to Chicago. To save space, and incidentally leave a few stupendous surprises for the scientific sensation

ON PARADE AT CHICAGO FAIR

seeker, the telephone exhibit will be passed over without further comment.

A group of utilities, through their committee, have achieved magnificently in their efforts to tell the public the basic technical story of electricity from coal mine and river to home, office and factory. The central exhibit of "Electricity at Work" is the greatest diorama ever made, a composite of painting and intricate models 90 ft. long. One sees here a vast expanse of country with mountains, rivers, plains, water coming down the mountains to operate hydro plants which deliver electricity over a transmission network to villages and cities. This diorama also contains a complete sectional model of a modern steam-electric station burning pulverized coal. The turbine turns; water circulates through the glass tubes of boiler and furnace walls; lights flash on and off as a mechanical voice tells the story.

This great diorama is typical of the technique employed in hundreds of other Exposition exhibits. Chicago has built a paradise for the lover of intricate models and for the man who likes to see how things work.

In "Electricity at Work" is also a remarkable cross-sectional model of a tandem-compound turbine generator and a historical exhibit in which models trace the development of the steam engine, the steam turbine and the generator from their ancient origins up to 1893, the date of the last Chicago Fair.

Westinghouse and General Electric stage elaborate and wonderful shows in the Electrical Building. In the G.E. section of 9,000 sq.ft., public interest centers on the "House of Magic" lecture demonstration, which will have all Iowa talking for the next thirty years.

Probably with an eye to the millions of housewives who will pass through this summer, other G. E. exhibits feature mainly household equipment, including the new air-conditioning unit for homes. But for engineers there are steam turbines, industrial applications of electricity and a model of the new $4,000,000 mercury steam plant.

Alongside the General Electric space, equally large and with equally interesting exhibits, is that of Westinghouse. Here the magic is out in the open, a string of "try it yourself" electrical stunts ranged along a gallery. Westinghouse perhaps offers more for the industrial visitor. On hand "in the flesh" are a 240-hp. (railway) diesel engine-generator set, a 1,500-kw., sectional, mercury-arc rectifier and a 35-ft. transformer model.

Beneath a glass floor, a thin full-diameter slice of a 77,000-kva. water wheel generator rotates visibly. Hung from the ceiling, turning slowly, is a full-sized model of a 100,000-kw. steam-turbine rotor.

Crane Company has two separate exhibits, one in the Electrical Building and the other in the special Crane building. The former, showing a variety of valves and fittings with typical applications, reminds the non-technical visitor that mechanical equipment, particularly piping, plays a major part in the production of electricity.

Other power-field exhibits in the Electrical Building include those of Sangamo Electric Company, Carrier Engineering Corporation and the Permutit Company.

Carrier Engineering Corp. shows the application of air conditioning to homes. Permutit also gives the home owner a break with examples of the household-size automatic zeolite softener (the industrial-size unit is described on page 374 of this number).

Two historic turbines are on display. One is the early De Laval, loaned by the De Laval Steam Turbine Co., which ran at Chicago's Columbian Exposition in 1893. The other, loaned by Allis Chalmers, is the Parsons machine built at Newcastle-on-Tyne, England, in 1884.

Space does not permit mention of the hundreds of remarkable demonstrations in the Hall of Science. Star attractions include basic models for mathematics, physics and chemistry, the $10,000 glass man with illuminated insides, complete working models of large chemical and process plants, Piccard's stratosphere gondola, etc., etc.

In this building is the very extensive exhibit of the Union Carbide and Carbon Corporation. As a part of it the Linde Air Products Company stages, for large crowds, a demonstration of oxy-acetylene welding.

The five wings of the General Exhibits Building contain several power-field exhibits. Armstrong Brothers Tool Company shows an extensive assortment of engineering tools. A great variety of Tinius Olsen testing instruments and machines are on display.

Among the features of the Link-Belt exhibit are many dioramas and working examples of the elements of drives and conveyors. Industrial applications, including coal and ash handling, are shown.

Builders Iron Foundry Chronoflo meters, measuring the entire water supply of the Exposition, are housed in glass and labelled for the instruction of visitors. The water-supply system, capacity 20,000,000 g.p.d., was installed and is operated by Yeomans Brothers Company, Chicago pump builder.

The Fair's chief amusement attraction, the "Skyride," is also a spectacular engineering achievement. Cars move back and forth on cables suspended between steel towers 628 ft. high, tallest in America west of Manhattan. Power equipment is on the job; Otis elevators take passengers to the Skyride level and also to the observation platforms on top of the towers. There all the elevator machines and controls are open to inspection and one can look down through glass plates at the moving cars.

One of the high lights of the Fair is the great building of General Motors, displaying actual production lines on cars and bodies. Much of the power for this operation is supplied by a complete diesel power plant, beautifully housed in glass and open to visitors. The main units are two Winton, 400-kw., 600-hp. 720-r.p.m. generating sets.

After a very thorough first-hand inspection, *Power* recommends the Century of Progress Exposition to every engineer. If you go be sure to visit at least the following buildings: Communications, Electrical, Hall of Science, Transportation, General Exhibits, General Motors.

ENGINEERS HAVE THEIR WEEK

THERE is too much to know! One comes to the end of Engineers' Week with this impression. Ringling has his three-ring circus, but engineers, naturally, could not be satisfied with so little. Was not the whole Century of Progress Exhibition—with due credit to artists, architects, business men and scientists—simply the net result of a century of engineering progress?

That may explain why twenty of America's most important engineering groups met in Chicago from Monday to Friday (June 25-30) and staged seventy sessions in which more than 200 papers were presented.

If ever a guide book were needed, it was here—particularly for the power engineer whose interests might easily touch those of a dozen different societies.

In the attempt to guide the feet of readers who were heading toward Chicago, *Power* published (in June) a composite program in which a solid page of fine type was required to list the cooperating societies and the papers of probable interest to power engineers.

For obvious reasons, the present report is very definitely limited to such papers and cannot include even all of them. No attempt at comprehensive abstract is possible, and few readers would find time, in any case, to read such a voluminous report.

The aim, rather, is to report this three-ring show of engineering knowledge by the process known as "high spotting." The editors here bring to the readers a running story of hints, ideas and conclusions, selected on the basis of their applicability to the readers' practical problems. Where desired, the complete papers (long abstracts in the case of the A.S.M.E.) can generally be obtained from the society concerned.

Society names are abbreviated. Sessions were held at the Palmer House, Hotel Sherman, Stevens Hotel, Edgewater Beach Hotel and Congress Hotel. As was to be expected, the A.S.M.E. sessions offered most to the power engineer, but many other societies had something to offer.

Engineers had their week at Chicago. More than that they had their day—June 28—and such a day. Undoubtedly, this was the largest and most spectacular gathering of engineers in America's history. For the story see page 350.

A.S.M.E. SESSIONS

Fuels — Combustion — Smoke — Creep — Turbine Blades — Diphenyl—Condensers—Power Cycles—Turbine Moisture —Pipe Bends—Boilers—X-Rays—Boiler Water

At Chicago, the A.S.M.E. sessions alone offered the power man *more* than a typical annual meeting in New York. Here are a few samples:

O. P. Hood reviewed a century of progress in fuel technology. E. H. Tenney showed how Cahokia handles pulverized coal as reserve and standby. The paper of James F. Muir showed that practically all types of pulverized coal furnaces can be changed over to oil at low cost. Two papers added to previous knowledge of "grindability" of coal as a measure of its probable performance in a pulverizer. P. Nicholls of the Bureau of Mines reported tests on the "underfeed' combustion of coals.

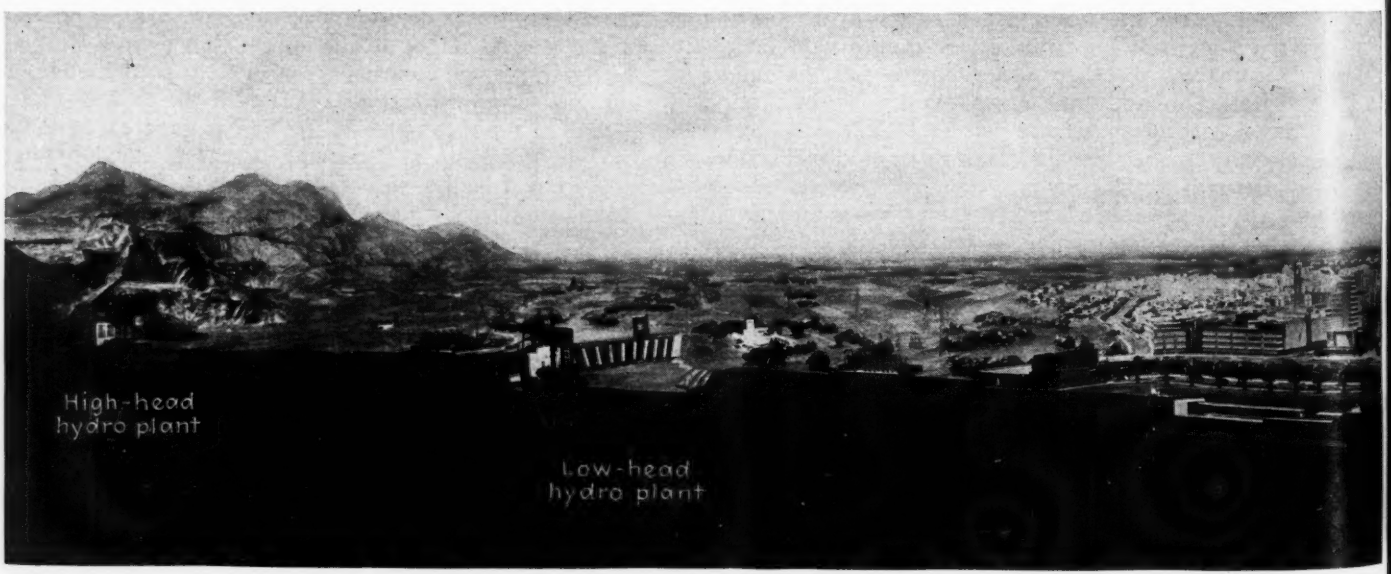
Several papers dealt with smoke and related problems with emphasis on the human side. Others dealt with "creep" tests of high-temperature tubing and with stresses in lashed turbine blades. Organic high-boiling point compounds, suitable for heat transfer, were described. There were two condenser papers, one on design and another on operating results (at Hudson Avenue).

Another paper compared the efficiencies obtainable with the various steam power generating cycles. Still others covered moisture in steam turbines, design of pipe bends, the latest boiler installation at Hell Gate, X-Ray developments and boiler-water conditioning.

In addition to its "solo" meetings, the A.S.M.E. held several important joint sessions with other engineering societies.

The following brief abstracts cover points of particular practical interest in

The 90-ft. diorama in the



the papers and discussions of the regular A.S.M.E. sessions. A similar report of the joint sessions, and of certain sessions of other societies will be found in the action sta ting on page 346.

Three papers of particular importance are given extensive presentation elsewhere in *Power* and so will not be abstracted here: E. A. Wert, S. Smith and E. T. Cope presented "Design Method for Flexible Piping Members," a development of the method described by them in the April number of *Power*.

In the June number *Power* printed for the A.S.M.E. the paper, by Landis and Tucker, giving the results of comparative tests of the world's two largest condensers (101,000 sq.ft.) at the Hudson Avenue Station.

On page 355 of the present number will be found W. E. Caldwell's paper "Large Hell-Gate Direct-Fired Boiler Units."

In discussion of Mr. Caldwell's paper, the unusually small space per 1,000-lb. of steam generated, and the quick starting up ability after over-night shutdown, were commented upon. The high carbon loss at maximum rating was thought to be caused by the decreased coal fineness due to operating the pulverizers 34 per cent above mill design capacity.

The Landis and Tucker paper led to considerable discussion. Paul Bancel disclosed that special model tests had been made to solve certain problems in the design of the Hudson Avenue condensers. Flow tests on 28 water boxes were made to determine the best hydraulic form of the inlet and outlet boxes. Model tests were also made to determine pressure loss through different tube banks at various flows. Actual design was based on the results. He also brought out that the first two compartments condense half the steam and that a negligible force is required to deflect the steam from the turbine exhaust to the cold end of the condenser.

Mr. Harwood compared the performance of the two condensers after correcting the performance of the Worthington condenser to the same circulating water quantities and temperatures and cleanliness factor as existed during the Ingersoll-Rand condenser test, using correction factors published in *Power*.

Mr. Morgan stated that the satisfactory performance of the condensers is not evident from the heat-transfer data reported and gave results obtained with condenser No. 6 at Hudson Avenue. He stressed the need of better distribution of steam at turbine exhaust and the effect of different air leakages on condenser performance.

A Century of Fuel Progress

A century of progress in fuel technology was outlined by O. P. Hood. The common fuels of a hundred years ago were wood, anthracite, bituminous coal and charcoal. At that time it was estimated that of the total fuel consumption 80 per cent was wood, 3 per cent charcoal, 2 per cent bituminous coal and 14 per cent anthracite. There was no coke industry, and natural gas was a curiosity. The distillation of oil from coal to produce coal oil or kerosene had not yet begun.

It is entirely within the period of the last century that petroleum and natural gas have been made availabe in quantities, and the technology of their recovery, transportation and use has been developed within this period. The great industry of processing coal to produce coke, gas, tar and other products has been developed, with something of importance happening in every decade for the last 70 years. The production of liquid fuels from coal, by using high temperatures and pressures in a complex technology, has recently been made possible. Another newcomer is liquified gas from petroleum. A century ago the heating of homes was perhaps the major use for fuel; today industry demands 85 per cent of the fuels used.

Discussing Dr. Hood's paper, E. G. Bailey said there is still room for development of furnaces to burn any coal, oil or gas with good efficiency, thus permitting the operator to take full advantage of shifting relative prices. This applies particularly to the burning of low-grade coals.

In further discussion, Joseph Harrington told of 33 years of experience in the combustion field. The stoker was a novelty in 1900; real refinements started about 1920. Today there is little room for increased efficiency. Mr. Harrington said the initiative in promoting fuel-burning progress is now shifting from the equipment manufacturers to the sellers of fuel, awakened by competition.

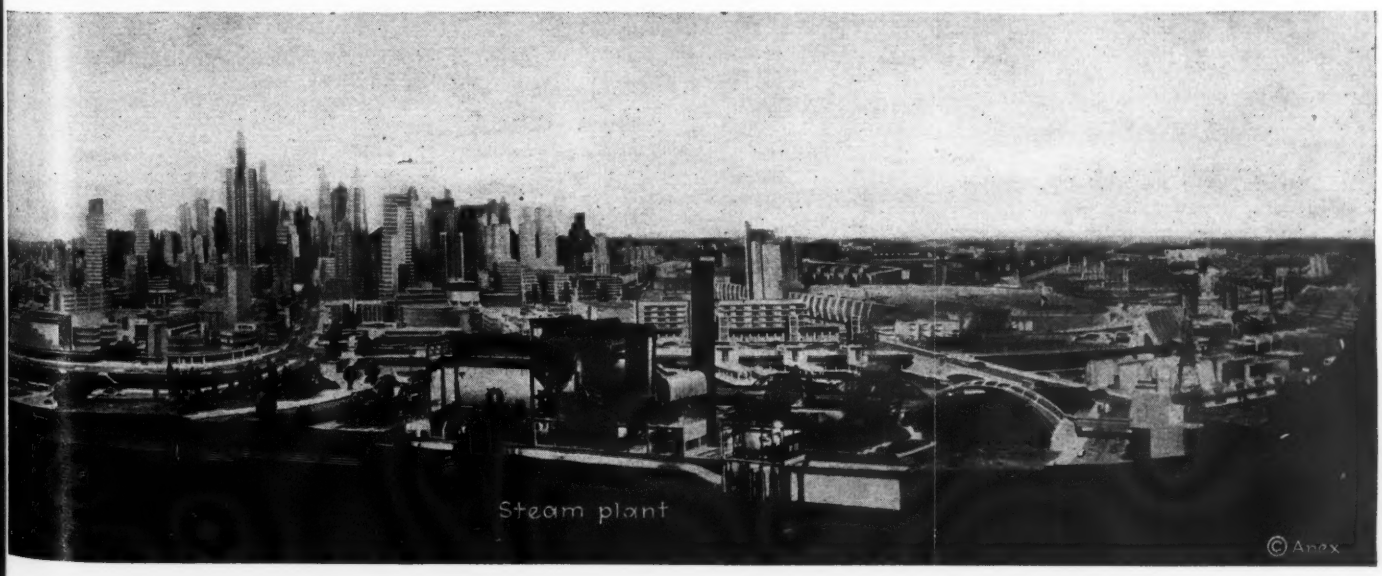
Standby and Reserve with Pulverized Fuel

Wider interconnections of generating stations, which permit efficient plants to be operated at high capacity with less efficient plants standing by, and the growing tendency more thoroughly to interconnect hydro with steam plants, leaving the later as standby during seasons of plentiful water supply, make the standby operation of generating stations a more important problem. The general procedure for analyzing problems of standby and reserve in Cahokia Station of the Union Electric Light & Power Co. (St. Louis) system, and the methods of operating its pulverized-fuel boiler plant during sudden load increases, were described by E. H. Tenney.

The ability of a plant to pick up load depends on the boiler room. The conditions to be met are imposed by the turbine and are controlled by the governing mechanism and the system frequency. To estimate the amount of load increase the Cahokia boiler room may be required to assume during a system fault, and to determine what improvements might be made to the various plant governors, an investigation was undertaken wherein the governors were analyzed.

The ability of a boiler room to meet a system fault condition depends on several factors, some mechanical and some human: (1) The ratio of the steam demand increase to the load being carried. Up to 25 per cent increase, increase in steam demand is easily handled by operating boilers at this amount below their maximum capacity. The severest case is the plant operating at the lowest possible load which will permit picking up the heaviest load reasonably expected. This is the case described, where the lowest load of 18,000 kw. permitted picking up 45,000 kw. more. (2) The time required to inform the boiler house crews of the fact that load must be picked up. A low-frequency alarm used at Cahokia sounds a

"Electricity at Work" exhibit



warning at 59.4 cycles. (3) The effectiveness of boiler-house organization for coping with sudden load increases. (4) The mechanical limitation of the boilers in respect to steam release and water storage, and (5) the rapidity with which increasing quantities of coal and air can be delivered to the furnace in combustible condition.

Discussing Mr. Tenney's paper, several operators of large central stations agreed that two or three minutes is about the limit of time during which stored energy can carry the sudden increase in load caused by a system fault. At the end of that time, firing equipment must be up to the new load. It was stated that the boilers at Huntley Station (Buffalo, N. Y.) have remote-controlled oil lighters which can light pulverized-fuel boilers in a few seconds.

According to A. E. Grunnert, each station on the Commonwealth-Edison (Chicago) system carries a certain amount of instantaneous reserve to divide the burden of emergency load. Stoker units operating at low load can get up to maximum output in 3 min., he said.

Shifting from Pulverized Coal to Oil

Many plants have changed from coal to oil firing in recent years because oil frequently costs less per heat unit. It is easy to fire oil in pulverized coal-burning furnaces equipped with horizontal cylindrical-type coal burners, but inter-tube and fantail burner installations give rise to economic as well as engineering problems in avoiding the dismantling of expensive coal-burner equipment and costly changes in water-cooled walls. James F. Muir, in his paper, "Oil Firing in Pulverized-Coal Furnaces," discussed the methods developed in a number of plants to cope with such problems.

Installation of oil-firing equipment in combination with Calumet inter-tube coal burners does not at first seem feasible. Nevertheless, at the Somerset Station two Stirling boilers, each equipped with four Calumet burners have been burning oil for the last three years. Four mechanical-atomizing oil-firing units are inserted through the secondary air port, and one in the coal-ignition opening of each coal burner. Because of insufficient clearance in the 9 x 4-in. air port, the oil burners are not equipped with diffusers, heretofore considered essential. Despite their omission, satisfactory burner performance is obtained by operation of both primary and secondary air systems. Both fuels are fired separately or simultaneously as required to meet local fuel requirements.

Another group of three Stirling boilers at this same station has been fired with oil in a downward direction in combination with fantail vertical burners. The furnaces are each equipped with eight Lopulco-type coal burners. Each of these units was revamped to accommodate two mechanical-atomizing oil burners. Combustion and burner performance with this dual arrangement are beyond expectations. From the conversion of combustion systems from coal to oil in the few plants included in this paper, and others not included, Mr. Muir stated his belief that pulverized-coal fired furnaces of water-wall or refractory construction are adaptable for oil firing with minor changes.

Interesting discussion centered around the statement that the burning of 10 or 15 per cent of pulverized coal with oil reduces corrosion or erosion of air-preheater tubes. It was suggested that this may be due to ash particles acting like a sponge or to their alkaline reaction. Mr. Muir said the ash particles also seem to scrub preheaters clean of soot. George Orrok warned those rebuilding furnaces for two fuels to design for high efficiency with both fuels.

"Grindability" vs. Pulverizer Performance

The relation of grindability to actual pulverizer performance was discussed by Martin Frisch and G. C. Holder. Engineers have long sought a simple laboratory test to measure some property of a coal that could serve as the basis for predicting the performance of large pulverizers with that coal. Several test methods have been proposed for determining the "grindability" of a fuel, which is defined as the ratio of new surface produced during the treatment of a small representative sample of a coal for a definite time in a special laboratory grindability machine to the surface produced with a standard or "100-per cent-grindability coal" treated in identical fashion. However, the relation between capacity and grindability for one type of pulverizer need not be the same for one as for another, or even for all sizes of the same type.

The specific surface at any stated fineness is quite different for different pulverized fuels.

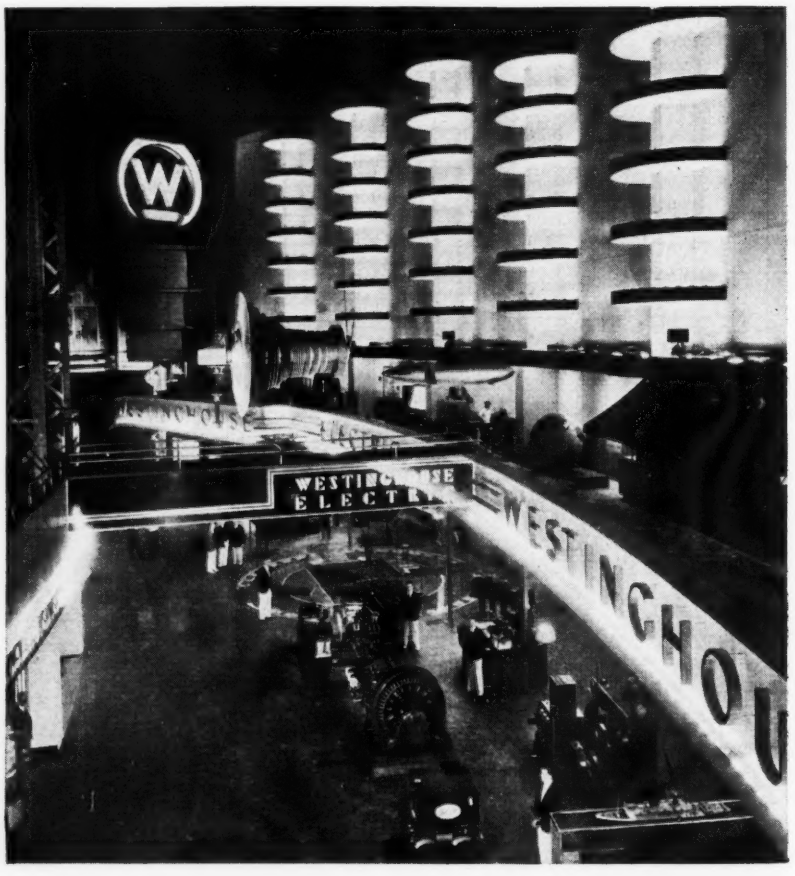
The results of a large number of ball mill and pulverizer tests were analyzed and reduced to a common basis by correcting for the effect of variations in fineness, feed size and moisture from the standard. When so corrected, laboratory grindability tests varied consistently with field tests of ball mills.

R. Sherman, in discussing the paper, stated that, if grindability is considered on the basis of surface produced, the size and surface of the superfines passing a 300-mesh screen must be investigated and considered. He agreed with the author that for mill capacity purposes, it is satisfactory to consider the percentage of coal through only one sieve. Mr. Van Brunt pointed out that it would not do to rate coals or mills on the basis of a certain per cent through a 200-mesh screen, because the fineness required of one type of coal for proper combustion may be altogether different from that required by some other coal.

Capacity, Power and Grindability Related

R. M. Hardgrove presented data showing the relation between pulverizer capacity, power and grindability for several types of pulverizing systems. Pulverizer tests, to be comparable, must be corrected to a standard fineness, which has been chosen as 70 per cent through 200 mesh. A correction factor based directly on the percentage of minus 200 mesh does not agree with actual test data as well as a straight-line relation of approximately 2 per cent for each per cent the fineness is above or below 70 per cent through 200

The Westinghouse Exhibit



mesh. This correction can be used over a range of fineness of 40 per cent to 90 per cent through 200 mesh, but increases rapidly above 90 per cent through 200 mesh.

A large number of tests, made with five different sizes of pulverizers of ball-bearing type, when corrected for fineness and plotted against grindability, show the capacity to be very nearly proportion to grindability, with material of 25 to 50 grindability, but with material having grindability above 50, the capacity falls off relatively.

The total power, at maximum capacity, is practically constant for all grindabilities, and if power is expressed in tons per kilowatt-hour, the relative power has the same relation to grindability as does the capacity in tons per hour.

Underfeed Combustion with Preheated Air

The characteristics of underfeed combustion and the effect of preheated air upon combustion have been investigated at the Pittsburgh Experiment Station of the U. S. Bureau of Mines and were reported by P. Nicholls and M. G. Eilers. The work was done in a 20-in. diameter refractory-lined firepot. Air supplied below the grates was controlled and measured. Underfeed burning was obtained by filling the firepot and igniting at the top. This gave an unrestricted ignition; that is, the plane of ignition could advance downward as fast as it was able with the constant rate of air supply used in each test. If the rate of burning is equal to the rate of ignition, burning is in equilibrium and the thickness of live fuel remains constant for a given air flow.

All fuels showed the same general characteristics, the only distinction being that up to a certain air rate the bituminous coals closed up the openings so that the air distribution and rate of burning were not uniform over the area of the bed.

Each fuel reached equilibrium at a certain air rate, and for higher rates the live bed would be in equilibrium, its thickness decreasing with increase in air rate.

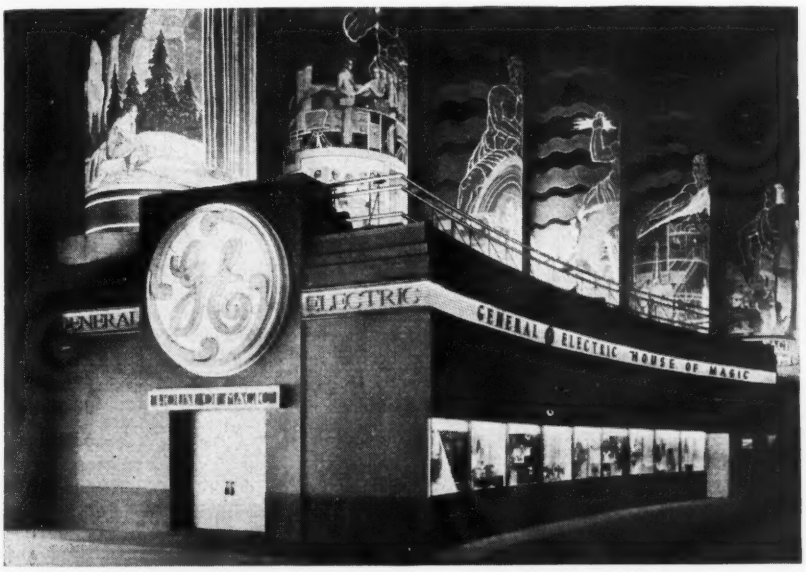
The rate of ignition did not increase indefinitely with increase of air rate; for the high-temperature coke it reached a maximum, and then rapidly decreased; with other fuels it reached a maximum and showed tendencies to decrease.

The rate of ignition, and consequently the maximum rate of burning attained, increased with decrease in size of fuel.

Preheat very materially increased the rate of ignition at all air rates; thus with the Illinois coal an increase from 80 to 300 deg. increased the rate of ignition, and the possible maximum rate of burning, 97 per cent.

Caking prevented uniformity of burning up to the air rate which gave equilibrium; for higher rates the fuel acted as free burning.

Joseph Harrington recalled experience confirming the author's findings that satisfactory combustion with a coking coal cannot be secured below certain air flow rates. Mr. Van Brunt pointed out that the paper had shown that preheated air makes possible thinner fuel beds and less draft for the same rate of burning.



The General Electric "House of Magic" at the Exposition

Replying to the question, "Is over-fire air a necessity?" Mr. Nichols said that perfect combustion can be obtained with all the air passing through the fuel bed.

Smoke, Cinder, Fly Ash

At the session devoted to smoke abatement, three papers were presented. One, by Wm. G. Christy, discussed the human side of smoke abatement. A paper by Arthur C. Stern presented the results of a study of the available measurement methods for cinder and fly ash.

The measurement methods investigated included filtration through cotton, woolen and asbestos bags of various sizes and shapes, through paper and alundum thimbles, through beds of granulated and pulverized sugar of various depths, and through asbestos wool; also, centrifugal separation in cyclone collectors of various sizes and proportions, electrical precipitation in precipitators of various dimensions using various potentials, and the Greenburg and Smith type of impinger.

Of low-sampling rate methods, the author prefers the impinger. However, a high-sampling rate method is generally preferable to a low-sampling rate method, because of the increased accuracy of sampling the flue gas in the duct. A comparison of the three high-sampling rate methods led to selection of the cyclone method as being the most useful for all-around test work.

The dimensions of the cyclone collector developed as a result of these investigations were evolved by first studying the effect of changes in size, shape and proportions of several glass cyclone models upon streamlines in the models.

The boiler-outlet cinder-dust loading, expressed in grains per cubic foot of flue gas, increases rapidly with increase in rate of burning coal expressed in pounds of coal per square foot of grate area per hour. Fly-ash dust loading, however, increases but little at higher rates of burning coal per unit furnace volume. By combining dust-loading data with coal and flue-gas analyses, it is possible to compute the weight of the dust as a percentage of the coal fired.

The third paper of this symposium dealt with the removal of sulphur compounds from waste gases, and was presented by H. F. Johnstone. He compared types of washers from the standpoint of application to the large quantity of gas from power-station boilers. The possibility of economically washing these gases with untreated water is very remote, he said. The limits imposed by the solubility of sulphur dioxide are those of the quantity of water required and the time and surface of contact needed. A study of the catalytic oxygen method for removing sulphur dioxide indicates that, since it is necessary to absorb the oxygen for the reaction in the water, the time of contact cannot be greatly reduced. The capacity of water for absorbing sulphur dioxide, however, can be increased by the presence of catalysts to a point where the total quantity of water required is less than 1 per cent of that required when untreated water is used. The catalysts having the greatest power are the salts of manganese and iron.

The rate of absorption of sulphur dioxide from flue gases by alkaline solutions has been measured in a packed tower washer and found to be nearly 50 times than when oxidation is used. A contact time of less than 1 sec. is required for approximately completed absorption. The disadvantage of using these substances has been in the cost of the chemical, which in the case of lime, may reach a dollar a ton of coal.

It is possible to make use of the high absorptive rates of alkaline solutions and regenerate the absorbing agent by heating to approximately 200 deg. Several salts of ammonia have been found to have a high capacity when used in this way, absorbing and liberating as much as 6 per cent by weight of sulphur dioxide when used for washing flue gases. The method is attractive both from the mechanical and economical viewpoint, since the by-product from the dioxide which is produced in the pure state has a considerable market.

Dr. Harvey N. Davis, president of Stevens Institute of Technology, discussed Mr. Stern's paper. The fly-ash problem, he said, is complicated by the fact that fly-ash recovery is expensive and saves no money, whereas smoke

prevention increases boiler efficiency. He said that the first cost of a pulverized-fuel plant, for proper comparison with a stoker plant, should include equal facilities for handling ash. Dr. Davis expressed the hope that a profitable outlet for fly ash will be found within the next two or three years.

Mr. Christy's paper led to a heated discussion of the human element in smoke prevention and how to handle it. Experienced smoke-commission men presented diverging views. Samples: With the recent advent of a new administration, smoke-abatement work lapsed in Cleveland and smoke immediately increased. Railroads in Hudson County, N. J., have cooperated with smoke commissioners and made marked improvement.

Smoke "education," said H. W. Evans of Chicago, is a waste of time. Nothing will work but police power penalizing smoking chimneys plus legal requirement of equipment to remove solids. Another speaker said the smoke problem will never be solved until smokeless equipment or fuels are required for household furnaces.

"Creep" in High-Temperature Tubing

A symposium of three papers was presented at the Iron & Steel Division Meeting of the A.S.M.E. on plastic deformation. Speaking on "Practical Plasticity Problems," George M. Eaton condemned the usual methods of comparing the creep resistance of steels intended to serve as still tubes and transfer lines. He listed the following fundamental requirements for creep tests for tubes in service: (1) The test piece must include the entire 360 deg. of a service tube. (2) The type of stress imposed by the test must correspond with service stress. (3) The tests must be conducted, not only on sections of tubes in the "as shipped" condition, but also and far more important, on sections of tubes removed from service after a wide range of predetermined lengths of time in service. (4) The tests must make independent determination of creep resistance on material located in three different portions of the cross-section of the tube. (5) The tests must be of short duration.

Effect of Lashing on Turbine Blade Stresses

Due to steam forces and centrifugal force, turbine blades are often severely stressed, and generally are subject to vibrations. It has been customary to strengthen the blades with lashing wires, shrouding strips and similar reinforcement. The paper by R. P. Kroon gives exact analysis for groups of three blades with lateral load only, and any dimensions of blade and wire. From this it is possible to find the deflection and bending moments for any blade out of a group of any number of blades. The maximum stress reduction which can be achieved by a single lashing wire is 33.3 per cent for uniformly distributed load, and 50 per cent for a load concentrated at the tip. A comparison of test results with the analysis showed the test results to be in good agreement with the theory. (Stresses within 7 per cent and deflections within 5 per cent.)

Organic Compounds for Heat Exchange

In a paper by J. J. Grebe and E. F. Holser, some of the physical properties of various combinations of diphenyl and diphenyl oxide were presented. The organic compounds discussed are known as Dowtherm "A," "B," "C," and "D."

The most recent of these products, Dowtherm "D," has the advantage of high boiling point and heat capacity per unit volume, and is entirely free from fire hazard. The material is suitable to use up to 600 deg. F., without pressure, is not corrosive and has no fumes or odors. Due to its fluidity, it may be heated electrically or directly by flame.

Some discussion developed concerning the use of organic compounds as a substitute for lubricating oils in an effort to overcome the fire hazard. Such materials have been tried but so far have not been successful because viscosity decreases too rapidly with increase in temperature. Dowtherm D has been tried out as a fluid in the governing gear of steam turbines.

Surface Condenser Design and Operation

In the paper, "Surface Condenser Design and Operation," Townsend Tinker discussed the fundamentals of heat transfer as applied to surface condensers, particularly the horizontal tubular type with the cooling water circulating through the tubes, and the natural operating characteristics of such condensers. Particular attention was paid to the effects of various physical arrangements on the operation of the condensing system. The studies indicated that certain condenser design problems have been poorly solved in some of the highly regarded designs. Where such instances occur, Mr. Tinker suggested alternative solutions more consistent with the recognized fundamentals discussed in the paper.

Mr. Morgan said that better condensers could be built if distribution of steam from the turbine exhaust were more uniform and showed how the steam distribution varies as indicated by actual tests.

Paul Bancel gave data to refute the author's conclusion that the pressure drop through the Ingersoll-Rand type of condenser is excessive.

Data was presented by H. M. Cushing showing the effect of decreased circulating water and air offtake at 5,000-kw. load on an 80,000-kw. turbine.

Heat-Power Cycles Compared

Recent extensions of pressures and temperatures considered practical for operation, and the publication of enlarged steam-table data, prompted a thermal study of

Models showing development of electrical generating equipment, in "Electricity at Work," exhibit of Electric Light and Power Industry

Models may be identified as follows: *Top row:* left to right—Thomas Edison, Dynamo and System of Generation, 1879; Z. T. Gramme, Ring Armature Dynamo, 1871; Antonio Pacinnotti, D. C. Dynamo, 1865; Dr. Warner Siemens, Shuttle Armature Dynamo, 1856; Hippolyte Pixii, Magneto-Electric Machine, 1832; Michael Faraday, Magneto-Electric Machine, 1831, Hans C. Oersted, Electro Magnetism, 1820, Andre M. Ampere, Magnetic Properites of an Electric Circuit, 1820; Alessandro Volta, Electric Cell, 1800; *Middle row:* Gustave DeLaval, Steam Turbine, 1889; Sir Charles Parsons, Non-Condensing Steam Turbine, 1884; Robert Wilson, Radial-Flow Turbine, 1848; Wolfgang DeKempelan, Reaction Turbine, 1784; Giovanni Branca, Impulse Turbine, 1629; Hero Turbine (Aeolipile), 120 B.C.; *Bottom row:* High Speed Horizontal Steam Engine, 1870-1890; George H. Corliss, Improved Steam Engine 1849; Arthur Woolf, Compound Steam Engine, 1804; James Watt, Double-Acting Steam Engine, 1782; James Watt, Single-Acting Steam Engine, 1769; Thomas Newcomen, Pumping Engine & Boiler, 1711; Thomas Savery, Pumping Engine and Boiler, 1698.

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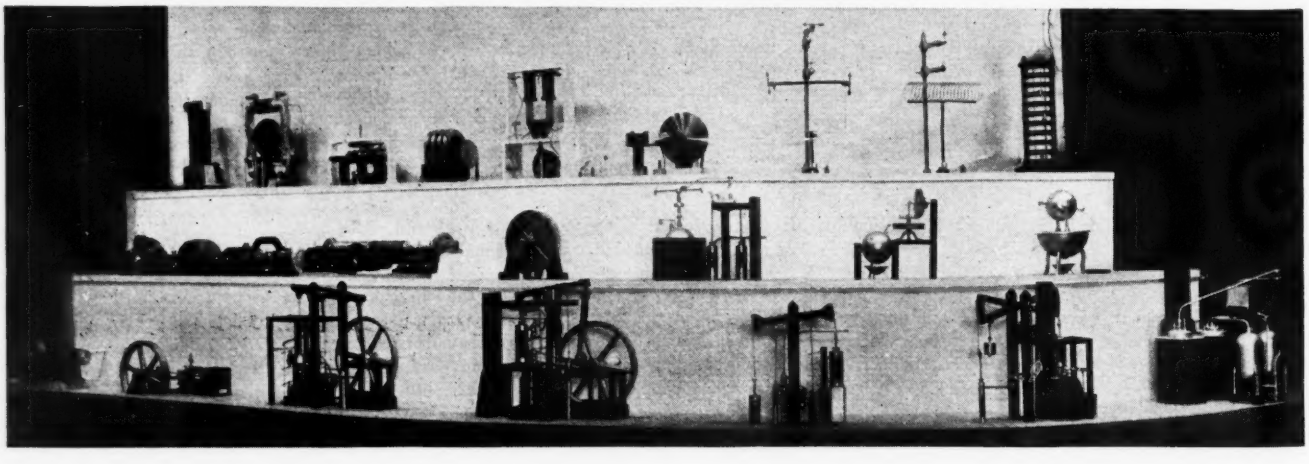


available steam turbine cycles, the results of which were presented in a paper, "Study of Available Steam-Power-Power Plant Heat Cycles," by G. A. Hendrickson and S. T. Vesselowsky. The purpose of the data included in the paper was to provide a means for quick, accurate comparison of the probable performance of projected plants over a wide range of the pressure-temperature-cycle, so that future projects may be developed along the most promising lines.

Two complete sets of heat rates are given, plant heat rates for estimating the rate of use of fuel, and turbine heat rates, with supplementary data for estimating the size of various equipment. The cycles presented included Rankine, regenerative feedheating, reheating regenerative feedheating, and a cycle using regenerative preheat of combustion air by bled steam. The initial steam conditions covered included temperatures of 700 to 1,000 deg. F., and pressures from 200 to 3,500 lb. per sq. in.

Moisture Problem in Steam Turbines

The paper, "Moisture Problem in Steam Turbines," by C. Richard Soderberg, reviewed the important aspects of moisture in steam turbines and discussed corrective measures available to the turbine designer.

Loss of energy by interference between the moisture drops and the steam in a reaction stage is found to be made of the following four components: (1) Exchange of momentum between steam and moisture in the stationary row; (2) impact against the back of the rotating row; (3) loss due to a certain portion of the moisture being forced toward the blade tips by centrifugal force; (4) exchange of momentum between steam and moisture in the rotating row.

The erosion problem is chiefly the result of the second loss component. It is now considered impossible to obtain sufficient erosion resistance by any known blade material fulfilling other requirements of strength and ductility. Nor have any of the possible methods of plating or surface treatment produced the desired results. This leaves as the only possibility the attachment of erosion-resistive shielding strips to the back of blades, the most promising of which, at the present time, appears to be Stellite. With Stellite shielding, tip speeds of 1,200 ft. per sec. have been reduced in erosion results to the level of 900 ft. per sec. applied to the best ordinary blade material now available.

Draining the moisture from one or several stages is another method of relieving the moisture problem. Detail arrangement of such moisture catchers were discussed briefly. When arranged appropriately, they permit elimination of up to 25 per cent of the moisture present in any stage.

Cheaper X-Rays of Welds

By the substitution of photographic paper for film and by other recent improvements, X-ray photographs of welds in pressure vessels and boiler drums can now be made at much lower cost. This was brought out by H. R. Isenburger, who described modern X-ray equipment and technique for this service. The paper, he said, costs less than one-half as much as film. It will also dry faster and is easier to handle and safer to use.

Mr. Isenberger described an X-ray unit, oil immersed, suitable for use in the boiler shop. This unit, designed for continuous operation at 300,000 volts, is 6-ft. long, 2-ft. wide and 3-ft. high. It is mounted on a trunnion support and set up on a little trailer for easy transportation.

Effect of Solids on Foaming

The effect of suspended solids on boiler-water foaming has been the subject of dispute. In this connection, many questions still remain unanswered, although the progress report of Sub-Committee No. 3 of the "Joint Research Committee on Boiler Feed Water Studies," threw additional light on the subject. This report, presented by C. W. Foulk, chairman, was based on experiments made with a model boiler arranged to permit the introduction of ground solid matter while operating under pressure up to 150 lb. The solid matter tried out was (150 mesh) boiler scale, limestone, dolomite and flint.

Surprisingly, the ground flint had no foam-promoting effect at any pressure. In fact, it seemed to make the boiling smoother.

The other solids induced foaming at the start, but rapidly lost their effect until finally they behaved like ground flint. The higher the pressure the more rapidly did they lose their foam-causing tendency.

The report pointed out that the conclusions would not necessarily apply to other substances than those tested.

In response to various questions, Professor Foulk replied that the greater the distance from the water level to the steam outlet, and the higher the pressure, the less priming takes place, and that more forming takes place with sodium sulphate solutions than with sodium chloride.

It was suggested that the increasing concentration during the test might have something to do with the ageing effect noticed and also that the decreasing water level occurring during the tests might cause the apparent decrease in priming, although the actual foaming might not have changed appreciably. Professor Foulk replied that he is now in a position to obtain a feed pump and will be able to verify these suggestions.

Soda for High-Pressure Boilers

For some years many boiler operators, particularly at the higher pressures, have made it a practice to avoid calcium-sulphate scale by maintaining the ratio of carbonate to sulphate in boiler water greater than a constant K, which was assumed to increase with temperature. On this point experimental results of great practical interest were presented by F. G. Straub of the University of Illinois.

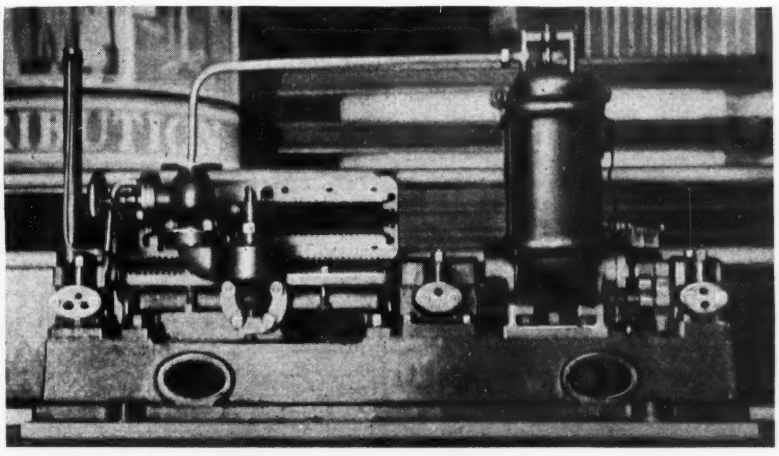
It has been the practice, in many plants, to shift from sodium-carbonate to other forms of treatment at pressures above 250 lb., in the belief that at these higher pressures rapid decomposition of sodium-carbonate would occur. It was felt that it was not practical to keep enough carbonate in the water to prevent scale and, at the same time, have enough sulphate to maintain the recommended A.S.M.E. ratio.

Professor Straub's tests, made first in a laboratory bomb and later in a small test boiler, led to some interesting conclusions. From 150- to 500-lb. pressure, calcium-sulphate scale formed at a rate practically independent of the rate at which the sulphate was added to the boiler. Scale formation seemed to be directly proportional to the heat transfer rate per sq. ft. per hr. Above 500 lb., according to Professor Straub, the rate of scale formation becomes lower. At 1,000 lb., it is about one-third of that at 500 lb. pressure and at 2,000 lb. it appears to be less than 10 per cent of that at 500 lb.

Professor Straub reported that the amount of undecomposed sodium carbonate necessary to prevent calcium-sulphate scale formation at pressures up to 2,000 lb. is less than 30 parts per million. This he said, indicates that it is practical in many plants to condition boiler water with soda ash or its equivalent at high pressures.

W. C. Schroeder observed that his work was in general agreement with that of Professor Straub, but that he felt a certain ratio between sodium carbonate and calcium sulphate is necessary to prevent scale and that this sometimes permits less than the 30 ppm. of sodium carbonate recommended in the paper.

J. D. Yoeder called attention to the



Historic Parsons Turbine

Built at Newcastle-on-Tyne, England, in 1884, this Parsons turbine was operated at Chicago's Columbian Exposition in 1893. It has been loaned by Allis Chalmers for display in the Electrical Building at the Century of Progress

fact that no reference was made in the paper to the greater need of protection in high-pressure boilers from even a thin layer of scale and that there is at high pressure, a tendency toward formation of silica scale. He advocated supplementing lime and soda ash treatment with phosphate. Phosphate prevents scale with lower total alkalinity.

Other discussion stressed the necessity of considering other things than calcium-sulphate scale in solving boiler feed-water problems.

In closing, Professor Straub said that funds have been made available to study the cause and prevention of silica scale as the next research problem.

Determining Sulphates in Boiler Water

To obtain a more accurate procedure for the determination of the sulphate ion in boiler water than now commonly in use as a control method, the Joint Research Committee on Boiler Feedwater Studies inaugurated a study of the known methods for this step in the analysis of water. The report was presented by W. C. Schroeder and C. H. Fellows.

Work incident to this study indicated that the gravimetric method for the determination of the sulphate ion is the most accurate and should be used in referee cases or other analyses where the greatest possible accuracy is demanded. For control work three procedures were outlined and compared.

C. H. Fellows stated that several of those using the tetrahydroxyquinone method have reported difficulty in determining the end point of the reaction, particularly when water tested is colored or when aluminum is present. It was said that in such cases the amount of indicator used can be doubled without affecting the accuracy of the results, and that this will make it easier to detect the end point. R. E. Hall described the technique he employs in using the turbidimetric method, which gives results with errors of not over about 10 per cent.

Measuring Dissolved Oxygen

The most accepted method for the determination of dissolved oxygen in water is the Winkler method. Because boiler feedwaters contain so little, and, in general, are required to carry no dissolved oxygen, its application in the examination of such water has met with difficulties, due to inherent inaccuracies where low concentrations of oxygen are involved. A study of methods for determining dissolved oxygen has been inaugurated by the Joint Research Committee on Boiler Feedwater Studies, the preliminary results of which were reported by S. J. Meisenburg and C. H. Fellows in a paper, "Determination of Dissolved Oxygen in Feedwater."

Since the Winkler method involves a starch-iodine reaction, and because there has been much criticism of this reaction, the initial work involved the establishment of sensitivity where different types of starch were considered.

The findings to date indicate the presence of impurities in the reagents, or of quantities of dissolved oxygen sufficient to vitiate the results. Errors in magnitude of 0.01 to 0.06 c.c. of oxygen per liter seem to be an inherent combined effect produced by the several reagents used.

Discussion disclosed that great care must be taken in sampling feed water when it is to be tested for low concentrations of oxygen. If rubber hose is used, oxygen will be absorbed by it. Red lead used in making up pipe joints will spoil the results. The Winkler method cannot be used if sulphite, used in some systems to remove oxygen, remains in the feed water sampled.

At the final A.S.M.E. session on Friday night, the speakers were Frank B. Jewett, vice president in charge of research, American Telephone and Telegraph Company, and A. P. M. Fleming of the Metropolitan Vickers Electrical Company, Manchester, England.

Engineers, said Dr. Jewett, must set their minds to the social problems created by scientific achievements. He felt that in the future many of the leaders in economics, business and government must necessarily come from the ranks of engineers.

Dr. Fleming urged the rapid development of entirely new industries as the best solution of the employment problem. These in turn always start with abstract ideas, as did the modern electrical industry.

Dr. Fleming's remarks on Russia were of particular interest because of his many visits to that country and also because of the recent international situation created by the arrest and trial in Russia of engineers of the Metropolitan Vickers Company. His comments, entirely objective, pointed to the probable success of the Soviet plans and to the increasing importance of that country in science and industry. He even hinted that the U.S.S.R. may eventually surpass western countries in these fields unless the latter develop a more perfect exchange of engineering and scientific information.

At this meeting, the Henry L. Gantt medal for achievement in the field of management was awarded to Henry S. Dennison, President of the Dennison Manufacturing Company. In his acceptance speech, Mr. Dennison approved the present trend toward more government in business and said that government is the greatest future field for management engineers.

Other Engineering Meetings

Water Hammer—St. Lawrence—Water Flow—Safety of Dams—Beauharnois—Port Washington

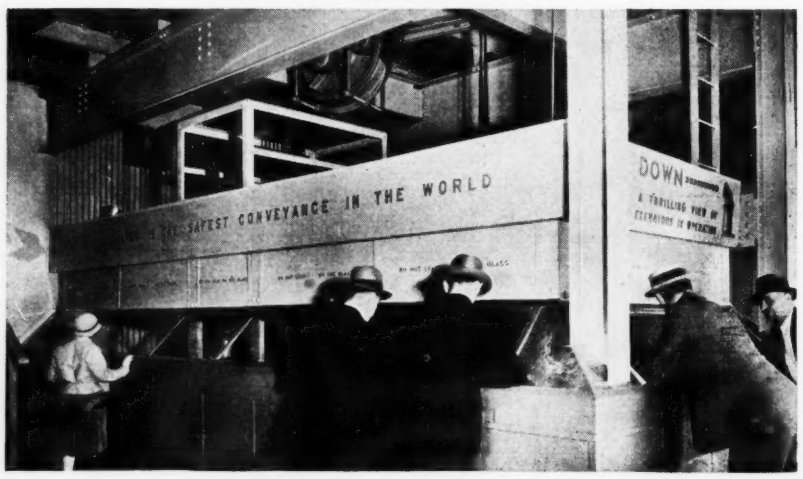
In addition to the sessions reported in the preceding pages, the A.S.M.E. held several joint meetings with other societies. Joining with the A.S.C.E., it studied the flow of water around bends in open and closed channels, the Power Committee report on legislation respecting safety of dams and the reports on the St. Lawrence power development. One joint session of A.S.C.E. and A.S.M.E. was devoted to a symposium on water hammer, covering a variety of problems of interest particularly to designers and operators of hydro-electric and pumping installations. Joint sessions with other engineering groups considered problems of broad economic interest.

Several other societies, notably the A.I.E.E., A.S.T.M., S.P.E.E., A.W.S. and N.D.H.A., presented papers of practical importance to power engineers. Some of these are covered in the following reports, particularly a very important paper on the design of the new Port Washington plant.

St. Lawrence Power Development

An analysis of the proposed official plans for water-power development on the International Section of the St. Lawrence River was presented by Dr. Daniel W. Mead, consulting engineer, before a joint meeting of the A.S.M.E., A.S.C.E. and A.I.E.E. In this analysis, attention was called to the fact that American engineers have consistently advocated a single-stage plan, while the Canadian engineers have con-

Elevator machine room in Skyride tower arranged so that the Otis elevator car can be observed in operation



sistently favored a two-stage plan for the development of this project.

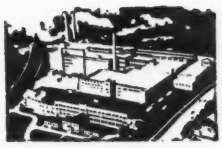
Three different plans were considered in the analysis: the single-stage Barnhart Island plan, the single-stage New York (Massena Point) plan, and the two-stage reconvened Crysler Island plan. The latter is the one upon which the treaty now awaiting ratification is based. It was pointed out that, although the two-stage plan is estimated to cost only $38,000,000 more than the single-stage Barnhart-Island plan, it is deficient in power output and earning capacity and will also be more expensive to operate. Because of this and other considerations, Dr. Mead estimated the cost of the two-stage development to be $93,000,000 greater than the single-stage Barnhart Island plan and $138,000,000 greater than the single-stage New York plan when power development only is considered. When navigation is included, the increase in costs become $95,000,000 and $154,000,000 respectively.

The Canadian engineers claim that the two-stage Crysler Island plan is preferable because it can be developed in two steps, while the single-stage Barnhart Island plan must be built in one step. This is correct, but Dr. Mead pointed out that the single-stage New York plan can be built in two steps and it was his opinion that this plan built in two steps is superior in every way to the two-stage Crysler Island plan built in two steps.

Professor Mead's paper, delivered before several hundred leading engineers, became the occasion of almost unparalleled bitterness. Frank P. Walsh, chairman of the New York power authority, violently attacked the speaker, accusing him of propaganda for the power interests and of deliberate distortion of facts. He also read a telegram from Senator LaFollette of Wisconsin attacking Professor Mead as a "reactionary" professor in the state university.

Mr. Walsh also attacked James W. Rickey, chief engineer, Aluminum Company of America, as a member of the committee inviting Dr. Mead to make his report.

The two-stage plan was defended by Dr. Thomas H. Hogg, chief hydraulic engineer of the Hydroelectric Commission of Ontario. He claimed that Prof. Mead's cost figures did not give a true comparison and also indicated that



Canadian authorities, for political as well as engineering reasons, are entirely set on the two-stage plan and that the development will be delayed indefinitely if it is not accepted. This point was also made by Col. E. M. Markham, Army Engineers, a member of the International Committee of the Joint Board of Engineers (reconvened) who also defended the adoption of the Crysler Island two-stage plan.

Frederick Stuart Greene, of the N. Y. Department of Public Works, wrote in, strongly objecting to the two-stage plan.

Before the meeting concluded, Prof. Mead and Mr. Rickey entered strong defenses of their impartiality and many society members present rose to defend their good names.

Symposium on Water Hammer

It has been recognized for some time by engineers concerned with the study of water hammer that many valuable contributions to technical literature have been made on this subject, but that many of the phases of this important problem have not been adequately covered in the English language. Where such contributions have been made, the distribution of the information has been extremely limited. To meet this need, a committee was appointed by A.S.M.E. to review existing information on water hammer, with a view to summarizing the theory, comparing the various methods employed, considering actual water-hammer problems, computing the pressure variations by various methods outlined, and determining which theories apply and which have been confirmed by actual experimentation.

From this study it was found that the subject of water hammer has been fully covered for conduits of uniform thickness and diameter, but that data lacking on the more involved problems of conduits having variable thickness and diameter and those having branch pipes. Arrangements were made with various American engineers to present treatises on these phases of water hammer in a symposium under the joint auspices of the A.S.M.E. and the A.S.C.E. A committee, composed of Norman R. Gibson, Eugene E. Halmos, Lewis F. Moody, Ray S. Quick, Earl B. Strowger, and S. Logan Kerr, chairman, submitted a report outlining the history of water-hammer theory and the early contributions of Joukowsky and Allievi in regard to simple conduits of uniform thickness and diameter. In this the various phases of water hammer were classified under five headings: (1) Conduits of uniform thickness and diameter, simple conduits; (2) Conduits of variable thickness and diameter, complex conduits; (3) Conduits having branch pipes, compound conduits; (4) Water hammer in pump-discharge conduits; (5) surge tanks.

The report included an Appendix showing typical examples of water-hammer problems and their solution, and also reproduced convenient charts previously prepared for the determinations of the maximum pressure rise and fall in simple conduits, a chart giving the velocity of the pressure wave, and diagrams illustrating the effect of non-uniform variation of discharge characteristics with respect to time, all of which affect the maximum pressure rise. In addition, the following seven papers dealing with different aspects of the problem were presented: "Simplified Derivation of Water-Hammer Formula," by L. F. Moody, professor of hyd., Princeton University; "High-Head Penstock Design," by A. W. K. Billings, vice-pres., Brazillian Traction, Light & Power Co., Ltd., O. H. Dodkin, hyd. eng., F. Knapp and Adolpho Santos, Jr., asst., hyd. engineers, Sao Paulo Tramway, Light & Power Co.; "Influence of Water Hammer on Design of High-Head Penstocks at the Drum Plant and Tiger-Creek Plant," by Walter Dreyer, asst. chief eng., Pacific Gas & Electric Co.; "Computation of Water-Hammer Pressures in Compound Pipes," by Robert E. Glover, eng., U. S. Bureau of Reclamation; "Effects of Surge Tanks and Surge-Tank Risers on Water-Hammer Computations," by Eugene E. Halmos, chief eng., Parklap Construction Corp.; "Surge Control in Centrifugal Pump Discharge Lines," by Ray S. Quick, chief eng., Pelton Water-Wheel Co.; and "Water-Hammer Tests in Croton-Lake Pumping Plant, by S. Logan Kerr, waterworks eng., Baldwin-Southwark Corp. Copies of this symposium and the discussion on it may be obtained from the American Society of Mechanical Engineers, 33 W. 39th St., New York City. Price $1 to members and $1.50 to non-members.

In presenting his paper, Mr. Billings said that penstock accidents have been far more frequent and serious than is generally realized. He felt that the lack of publicity as to the facts has seriously retarded progress. Moreover, Mr. Billings pointed out, the penstock may in certain cases cost more than all the rest of the plant combined.

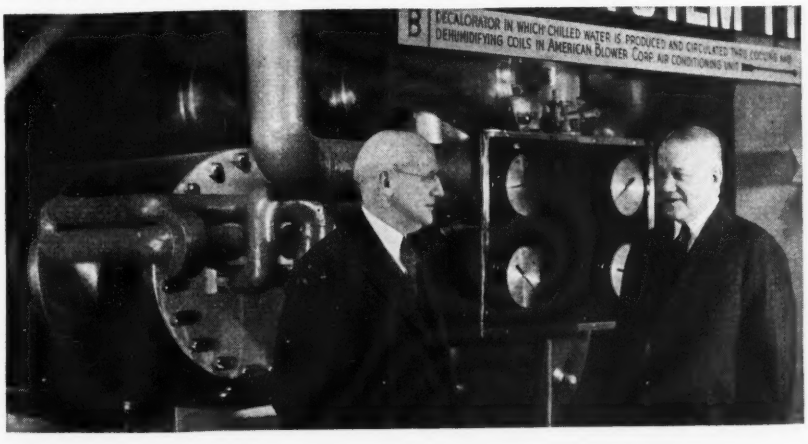
Other points made by Mr. Billings were that surges may start at the top as well as the bottom, and that present design methods are distinctly unsafe and also wasteful of investment.

H. L. Doolittle of Los Angeles discussed fatigue failure of penstock bolts. For this cause, he said, it has been necessary to replace all of the bolts of a penstock installed in 1916.

Other discussion brought out reports of many cases of the transfer of surges

When Steam Makes Ice Water

The new Decalorator, a steam refrigeration plant, uses only steam and city water to produce "ice"-water for the large air-conditioning plant being operated by American Radiator & Standard Sanitary Corp. in the "Home of Artificial Weather." The men are David E. Kennedy and Wm. M. Scudder, vice-presidents.


DECALORATOR IN WHICH CHILLED WATER IS PRODUCED AND CIRCULATED THRU COILS AND
DEHUMIDIFYING COILS IN AMERICAN BLOWER CORP. AIR CONDITIONING UNIT

from main lines to branches and vice versa with disastrous results, both in hydro-electric and city water systems.

Committee on Safety of Dams

At a joint meeting of the A.S.C.E. and A.S.M.E., a report of the A.S.C.E. Committee on "Legislation Respecting Safety of Dams" was presented. When the committee was formed, it was expected that several states, following the St. Francis Dam disaster in California, would soon enact regulatory legislation, much of it bad and so restrictive as to prohibit development. It was thought at that time that engineers interested in this class of work should exercise their influence to direct such legislation along sound and reasonable lines when the need might arise.

The committee stated its belief that regulatory legislation along sound lines is desirable in the interest of public safety in states where the construction of large dams whose failure might cause extensive loss of life and property may be anticipated. Active promotion by the Society of regulatory legislation was not advocated generally by the committee. It felt that such legislation should be supported or opposed by members of the Society in their own states in accordance with local, physical and political circumstances. Where such legislation is appropriate, or is actively under consideration, the committee believed that the influence of the Society and its members should be exerted to secure the enactment of the most desirable legislation. To this end a draft of a proposed regulatory bill was presented as part of the committee's report. This bill follows the general plan of the California law and fixes the responsibility for the exercise of the authority of the state in a department to be designated in conformity with the government organization of any state.

It was observed in the discussion that the recommended legislation does not make the state liable for the safety of the dam and that unless this is done there will be insufficient incentive for the appointment of engineers competent to judge the safety of dam designs and construction. The chairman replied that, as far as he knew, no state will accept liability for dam failure, even though its engineer may have judged the design safe. In states where few dams are constructed, it was suggested that a simplification of the recommended legislation is warranted and that the State Engineer might base his judgment of dam safety on the character and integrity of those designing and building the structure. Complete supervision of construction by the state may encourage an owner to depend entirely upon the state for this work.

Beauharnois Hydro Plant

As part of Engineering Week's activities, the A.I.E.E. held its 49th annual convention, which proved to be one of the most successful in the Institute's history. A total of 36 papers were presented and discussed at 10 sessions. In addition to this program, opportunity was afforded to attend other engineering society meetings of interest to power and electrical engineers.

The three power-plant papers on the electrical-engineer's program were of particular interest to *Power* readers as they presented the design and economic features in some of most recent hydro and steam developments. The water-power paper was by W. S. Lee, past president of the Institute.

Mr. Lee described the Beauharnois development on the St. Lawrence River. The power house design is laid out for a total of forty-two 50,000-hp. main units and two 7,800-hp. service units. Four 50,000-hp. main units and the two service units went into operation Oct. 1 of last year. To meet present power contracts, six more 50,000-hp. units are to be installed prior to October, 1937. This will leave space in the present power house for 4 more main units, a total of 14, which is one-third of the ultimate development.

The canal, which is 15 mi. long and has a water surface 3,000 ft. wide, is designed to carry the total flow of the river, 220,000 sec.-ft. As part of the Great Lakes deep-water system, this canal extends from Lake St. Louis to Lake St. Frances where the total fall in the river is 83 ft.

In a discussion, N. B. Higgins, Pennsylvania Water & Power Co., called attention to the uniformity of flow in the St. Lawrence, almost without parallel in the world. The project, he said, is well adapted to step-by-step development.

One speaker said that the projected ultimate addition of 2,000,000 hp. of generating capacity in this region is hard to imagine. For lack of time much additional discussion was held over for later publication by the A.I.E.E.

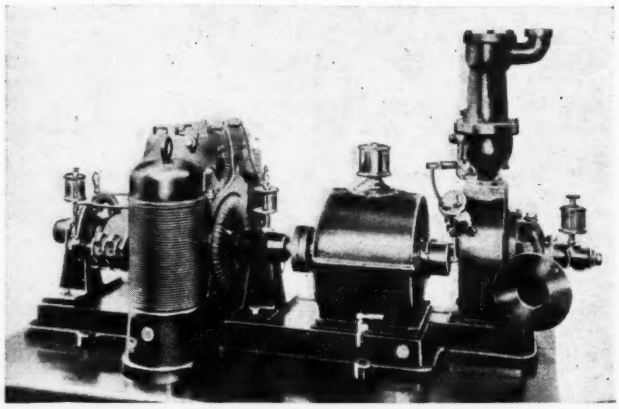
Burlington Station

The recent development at Burlington steam power station of the Public Service (N. J.) Electric and Gas Company, described in a paper by W. L. Cisler and W. P. Gavit, is of special interest in these times of stringent economies and effort to make existing equipment meet load requirements. The station contained three 12,500-kw. turbine generators, from 10 to 16 years old, with stoker-fired boilers operating at 200 lb. pressure and 150 deg. F. superheat. The fuel consumption was the equivalent of 22,000 to 25,000 B.t.u. per kw.-hr., which was about what could be expected for such a plant.

The installation of a 650-lb. 850-deg. F., pulverized-coal-fired boiler and an 18,000-kw., high-back-pressure turbine-generator exhausting into the 200-lb. steam mains, reduced the station heat rate to about 15,000 B.t.u. As a consequence of this improved economy, Burlington station is now prime base-load capacity and may be expected to continue in this service for some years. For a description of the high-pressure turbine in this plant see *Power*, February and March numbers.

First steam-turbine generating unit operated commercially in the United States

Used at the previous Chicago World's Fair, this single-stage, impulse-type turbine ran at 24,000 r.p.m. to drive the 110-volt d.c. generator at 2,400 r.p.m. through a DeLaval double-helical, speed-reducing gear.



PORT WASHINGTON 1200-LB. PLANT NOTABLE

A NOTABLE A.I.E.E. paper on a notable power plant was presented by G. G. Post, vice-president of the Milwaukee Electric Railway & Light Co. It dealt with the 1,230-lb., 825-deg. Port Washington plant now nearing completion. This abstract touches briefly the high spots of the elaborate analysis reported in Mr. Post's paper.

The Port Washington generating station is on the west shore of Lake Michigan at East Port Washington, Wis., 28 miles north of Milwaukee. Initial capacity will be 80,000 kw. (one unit) with a possible ultimate of 400,000 kw. (five units).

The location chosen permits delivering water-borne Eastern coal at a lower price than railside Mid-West coal, on an equal B.t.u. basis. Lake Michigan supplies ample and cold condensing water. Harbor facilities are already established. The location is one attractive to large industries, which on arrival, could be served with energy directly from the station busbars.

Before deciding on the temperatures, pressures and cycle adopted, elaborate cost comparisons with other combinations were made. In particular, the mercury-steam cycle was carefully considered in view of the possible demand for process steam by new industries in this location. For a given process steam demand, the mercury cycle can generate over twice as much by-

product electrical energy as can a straight steam cycle. For a straight condensing basis, it was found that the 1,200-lb. steam cycle would save $18.74 per kw. in investment, and run higher by 2,550 B.t.u. per kw.-hr. in station heat consumption. With $3.60 coal, the total yearly costs balanced at a load factor around 67 per cent.

The mercury cycle was discarded because, under the conditions, there would be little, if any, net saving over 1,200 lb., because less experience had been had with this cycle, and because a change to the mercury cycle in succeeding units could easily be made, if later desirable.

Experience with Lakeside high-pressure steam plants, initiated in 1926, was utilized in the design. Moreover, Lakeside's high-pressure system had, in 1929, affected an actual net saving of $58,965 over straight 300-lb. equipment of the latest design. Maintenance costs were equal. Coal saved was $89,365. Fixed charges were $30,400 higher. This definitely established the superiority of 1,200 lb. over 300 lb. An analysis of a 600-lb. set-up showed that this too was decidedly inferior to 1200 lb.

The Benson cycle was considered, but found to show practically no advantage over 1,200 lb., because of high feed pumping cost.

Consultation with manufacturers of superheaters, valves, pipes and turbines showed that engineering advances, particularly in metals, had made 825 deg. temperature conservative. This, then was adopted for both throttle and reheat temperature, (with a maximum limit of 850 deg.). The additional cost of 850-deg. equipment over 750-deg., was $28,170, amounting to $3,650 per year at 13 per cent. The fuel saving, on the other hand, amounted to $18,720 a year, leaving a net saving of $15,070 per year.

Lakeside's operating experiences with reheat are positive proof that variable loads are easily and safely carried. Reheat was adopted.

The selection of one tandem-compound 80,000-kw. unit, rather than two 40,000-kw. machines, for the initial installation, saved $7.15 per kw. in installation, and about $25,000 per year in operating costs, due to better heat rate.

One boiler was selected, rather than two, because $250,000 could be saved in investment, operation would be simpler, and because the presence of an 80,000-kw. turbine on the system would require that amount of system reserve in any event.

Experience at Lakeside favored the three-drum, bent-tube boiler with low-heat-release, hopper-bottom furnace, but this was adopted for Port Washington only after an elaborate comparison of both types. Advantages considered included greater water storage, more rapid circulation, action of rear drum as a dry drum, accessibility of water-wall connections, easier removal of suspended solids in the lower drum.

Slag-tag furnaces were considered, but were discarded because of a variety of considerations, involving, among others, difficulties in the use of radiant superheaters and reheaters. Radiant heat absorbing furnaces were selected for both superheater and reheater. In this the large low-heat release furnace was a factor. The superheater has also a convection section. After careful analysis, five-stage heating with an air heater, but no economizer, was chosen as the most economical.

Studies definitely favored the bin and feeder system over the unit system of pulverized coal firing for the existing conditions. Advantages listed for the bin and feeder system included greater reliability and flexibility, better use of flue gas in mill drying, closer regulation of coal feed and more positive operation of automatic combustion control.

The net effect of all these advantages totals 2.1 per cent in station economy; investment costs were found to be 74 cents per kilowatt lower for the unit system, which also showed a slighly lower labor, maintenance and power cost. The storage system was considered safer. In the Port Washington installation a 12 per cent volume of CO_2 is maintained in the mill system and collectors to reduce fire hazards. The analysis showed the bin and feeder to effect a net annual saving of $11,000, which, together with other operating advantages, formed the basis for its adoption.

To avoid pump difficulties from high and variable water temperature at feed-pump inlets, the feed pumps were located after the second heater and made to discharge through the heaters at the remaining three extraction points. The temperature of the water at the feed pump could be held practically constant at 200 deg. Moreover, this arrangement saves 12 per cent of the pumping energy, because of the lower specific volume of 200-deg. feed water. This far more than offsets the higher cost of the high-pressure extraction heaters.

Two sets of extraction heaters are used, and two feed pumps, one on each of the feed lines with a spare pump that can be connected to either line. Bolted heads with gaskets and staybolts are eliminated in the high-pressure heaters. Steel tubes with U bends were selected as cheaper and more reliable than brass tubes.

[*The complete paper gives Mr. Post's analyses in detail, and also includes six tables of comparative costs, as follows: 1,200 lb. vs. 300 lb.; 1,200 lb. vs. 600 lb.; 825 deg. vs. 750 deg.; bent-tube boiler vs. straight-tube boiler; four bleed heaters plus economizer and air heater vs. five bleed heaters plus air heater; storage system of pulverized coal vs. unit system*—Editor.]

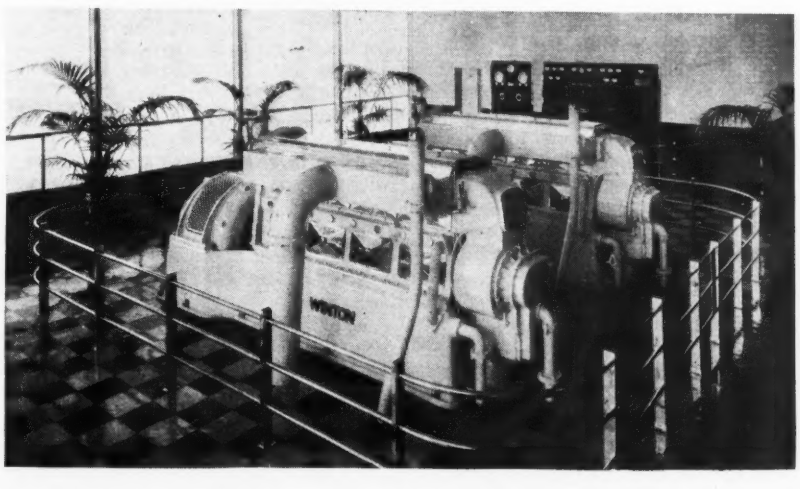
Mr. Post's definite statements on many controversial matters of design, together with the generally admitted excellence of his paper, led many engineers to submit discussions, only a few of which could be presented for lack of time. It was understood that the additional discussions will be held for later publication by the A.I.E.E.

The following is a brief summary of comments read at the meeting: Melvin D. Engle of the Edison Electric Illuminating Company, Boston, cited pioneering achievements of the Milwaukee group with pulverized coal, 1,200-lb. pressure and 825 deg. temperature. He indicated that very close steam temperature control will be necessary to avoid trouble. He wondered whether the large furnaces will justify their cost. He did not agree that the bin-and-feeder system of pulverized coal is superior to the unit system, but praised the selected design of high-pressure bleeder heaters.

Prof. A. G. Christy, of Johns Hopkins, questioned the assumption of 60 per cent annual load factor during life of plant; he thought it too high. He predicted 1,000-deg. stations in a few years. The choice of the bin-and-feeder system is contrary to the present trend, he said.

A Modern Diesel Power House

Two 400-kw., 600-hp., 720-r.p.m., 8-cyl., 8x10-in. welded-steel type Winton 2-cycle diesels supply power for the General Motors building. Uni-flow scavenging is accomplished by taking in scavenging air at the bottom of the cylinder and passing out exhaust gases through four valves in the head. This gives much higher m.e.p. than customary even in 4-cycle engines, yet engine temperatures are below usual practice. Blower has three helical lobes and provides air to scavenge at 3½ lb.



American Society of Refrigerating Engineers

The American Society of Refrigerating Engineers held their summer meeting in Chicago during the first two days of Engineering Week. The three technical sessions were devoted to current refrigerating, air conditioning and thermal problems.

C. Guild presented a paper in which he described a new type of condenser consisting of vertical tubes with the

cooling water arranged so that it flows down over the outside of the tubes containing the condensing ammonia. Taking advantage of the cooling effect produced by the evaporation of some of the cooling water, only 1.8 gal. of 70-deg. water per ton of refrigeration is required with 135-lb. head pressure.

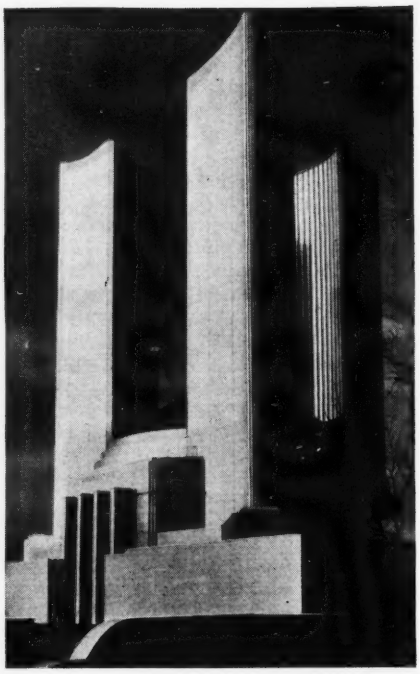
Natural Gas Engine Power

Operating costs in three plants that had changed over from electric motor drives on ammonia compressors to natural-gas engine power, were compared in a paper presented by C. T. Baker. In each case the cost of power, when using natural gas, was found less than the cost of electric energy. In one case the average cost of electric energy with 53 per cent load factor was $1.09 per ton of ice, and when using natural gas with a 35-per cent load factor power cost 64 cents per ton. In another 20-ton plant, the savings of natural gas over electric power amounted to $2,213.52 during a 7-month period.

Discussion brought out that a 20-yr. life had been used in estimating costs. One gallon of lubricating oil for about 1,500 hp. hr. of gas engine operation was used. Gas at 30 cents per 1,000 cu.ft. about equals Diesel engine fuel at 6 to 7 cents a gal.

Prof. H. J. Macintire and G. Edwards presented a paper showing that the general equation of fluid flow may be used in determining the pressure loss for any fluid flowing in a given pipe, provided the experimental constant k and exponent of the velocity is known for the particular pipe. They stated that the practice of assuming that the head loss varies as the square of the velocity instead of using the actual exponent is misleading.

R. M. Buffington discussed the problems encountered in designing a generator and absorber for an absorption refrigerating system using strontium chloride which has the property of absorbing molecules of ammonia when cold and giving off ammonia when heated. The system is intermittent in its operations, the same structure being used alternately as absorber and generator. To overcome the difficulties caused by the swelling and contracting of the strontium chloride as it absorbs and generates ammonia, a solution of lithium nitrate in ammonia is used with the absorbent.



Three fluted towers, 150-ft. high, rise around the 75-ft. dome of the Federal Building

The towers, representing the three branches of government—executive, legislative and judicial, are silhouetted at night by unusual lighting. The building itself is 620 ft. long by 300 ft. wide with a 70-ft. rotunda surmounted by the dome.

National District Heating Association

L. F. Collins reported for the Corrosion Subcommittee of the National District Heating Association the experience obtained with the corrosion tester developed by the N.D.H.A. By comparing corrosion results on the tester with actual pipe corrosion, the tester has been calibrated so that an average penetration of 0.010 in. per year represents negligible corrosion, from 0.010 to 0.020 in. penetration per year represents mild corrosion, and anything greater than 0.020 in. per year active corrosion.

Corrosion rate has been determined in 55 cases. This reveals that negligible corrosion is caused by condensed steam from distribution mains and from drips and condenser steam from risers in either pressure or vacuum heating systems. Condensate from dry or wet returns in pressure heating systems causes only negligible corrosion, but in vacuum systems the corrosion shown by the tester from return condensate varies from mild to active. Condensate from pressure water heaters shows very active corrosion.

Investigation of oil and sodium silicate was investigated in two buildings. In both buildings sodium silicate was effective but oil was effective in only one, largely because the amount of oil introduced was less.

In a paper, "Steam Refrigeration and Air Conditioning," by R. M. McQuitty and R. M. Mullen, presented as part of the N.D.H.A. Research Committee report, a comparison was made of the cost of vacuum refrigeration with water as the refrigerant and electrically driven chairman of the Guggenheim Medal Board.

It was pointed out that the efficiency of vacuum refrigeration is not as high as that of the positive compressor type, but when low-price steam is available it is frequently the more economical for air conditioning purposes. A factor in determining the economics of steam-jet type refrigerators is the cost of cooling water or of operating cooling towers, the amount of water required being two to four times that required by mechanical refrigeration.

A 100-ton system shows a difference in first cost of $6,340 in favor of the steam-jet and a difference of $281.52 in operating cost in favor of the mechanical compressor. With fixed charges at 12 per cent, the steam-jet system saves $479.28 a year.

Comparisons were also made for installation of 50- and 25-ton capacities.

In discussion, S. Sanford expressed the opinion that the cost figures used for the smaller mechanical compressor refrigeration units are too high.

A very excellent paper by M. W. Benjamin and R. G. Felger presented a study of by-product power generation cycles for use in district heating plants.

Fourteen different cycle-pressure and temperature combinations are compared for a maximum heating steam demand of 300,000 lb. per hour and the economies worked out.

If advantage is actually taken of the peak sharing ability of the by-product cycle and no duplication of investment is incurred, not only is a large investment saving by combining the functions of steam and electricity supply, but there is a substantial operating saving. The best cycle studied shows an operating saving of $53,620 a year and a decreased investment of $605,000.

ENGINEERS HAVE THEIR DAY

CHICAGO'S Engineering Week rose to its dramatic climax on June 28, Engineers's Day. Twenty engineering societies dropped technical sessions to permit engineers of all branches to come together for mutual inspiration. This experiment, the greatest of the sort ever attempted, was a magnificent success.

In the morning, two thousand engineers assembled in Soldiers Field, Chicago's stadium, to see a great inventor come down out of the sky to receive honors. The evening's banquet, one of the largest ever held by engineers, was notable for the number of outstanding engineers present, and even more so for the importance of its two principal addresses.

Almost on the dot at the scheduled 10:30 A.M., the Autogyro settled down gently behind the speakers stand in Soldiers Field. Crowds cheered, bands played and troops marched. Juan de la Cierva, Spanish mathematician, who a moment before had been suspended in air by the strength of his own formulas, stepped from the cabin of his "flying windmill." With him came the pilot, James G. Ray, and Harold F. Pitcairn, pioneer American interested in the 'gyro.

Formal speeches were made by Harry B. Gear, Chairman of the Engineering Societies committee, by Dean A. A. Potter, president of A.S.M.E., H. C. Dickinson, president of S.A.E. and Edwin E. Aldrin, chairman of the Guggenheim Medal Board

Pitcairn reviewed the achievements of Cierva. Aldrin presented the medal (its third award; Wright was first) and Cierva

Juan de la Cierva, right, recipient of the Guggenheim medal for invention of the Autogyro

responded. Col. Wattling led a battalion of U. S. infantry in parade in honor of the inventor.

Cierva's remarkable career, as outlined by Dean Potter, is notable for his application of abstruse mathematical analysis to a revolutionary new invention. Such talents are rarely joined in one man. The colorful ceremonies served equally to honor Cierva and to dramatize the essential role of engineers in this century of progress.

Space permits only brief and inadequate summaries of the important addresses delivered in the great ball room of the Stevens Hotel. One thousand engineers and banquet guests, including outstanding scientists and the presidents of twelve engineering societies, heard E. J. Mehren and Karl L. Compton, M.I.T. president.

Mr. Mehren dramatically pictured the engineer facing with pride his great achievements while the world blames him for all its troubles. Progress, he said, lies in three things: ability to produce and distribute wealth, high intellectual achievement and moral development. By reaching the first goal the engineer has made the other two possible, although educators, moral leaders and politicians have prevented their full achievement.

Mr. Mehren reminded his listeners that power, the dominant engineering factor, has been with us for only two centuries of the sixty centuries of recorded history. There is still time for man to learn to handle his affairs under the new régime.

In his forceful speech Dr. Compton looked at the past and turned to the future as symbolized by the Century of Progress Exposition. Chicago's development of this Exposition in times of depression, he said, is one of the seven wonders of the world.

Dr. Compton said that human organizations seem to follow a law like the second law of thermodynamics. Left to run itself, the farm goes to weeds, the city becomes chaotic, the nation falls into endless confusion. Disorganization is the natural trend unless overcome by conscious control. Invariably, control involves some loss of individual freedom of action, but that is the price of the accomplishments of cooperative effort.

THINGS SEEN at the POWER SHOW

CHICAGO'S power show—officially the 6th Midwest Enginering and Power Exposition—was almost lost in the shuffle this year. Held in the Exhibit room of the Stevens Hotel during Engineering Week, it was forced to compete for exhibitors and attention with the great Century of Progress Exposition.

However, as always at power shows, there were things to be learned and new products on display. Armour Institute of Technology, Chicago, demonstrated testing devices developed in its engineering laboratories. One was a machine to measure belt slippage, designed by Prof. Daniel Roesch of Armour. On the shafts of equal-diameter pulleys, connected by the belt to be tested, are brass pointers on insulated disks. These rotate within stationary brass rings graduated in degrees. At each revolution of the driver pulley, sparks are passed from the pointer of each shaft to the corresponding graduated ring. Angular difference between the spark positions on the two rings gives the cumulative slip.

For testing pressure gages, the Institute presented a device incorporating a Toledo springless dial scale as the measuring device. There are two gage manifolds, each providing for four gages. The two manifolds, fed with oil by an Alemite lubricator, are connected to rotating plungers of different sizes for different pressure ranges. Through ball thrust bearings, the plungers press on the scale platform. For each pressure range, a properly calibrated scale, giving direct readings of pressure, is laid over the dial face.

In the same booth, the Power Model Boat & Airplane Co. displayed the smallest commercial internal-combustion engine ever built: $\frac{1}{8}$ hp. Bore is $\frac{7}{8}$ in., stroke $\frac{3}{4}$ in., speed up to 3,800 r.p.m. Weight, including a complete carbureter 1 in. high, is 8 oz. This unit is sold to operate model boats and airplanes.

New equipment of interest in the Yale & Towne booth included a line of rotary piston pumps and a chain hoist designed for low headroom. The Tri-Rotor Piston Pump is a compact unit designed particularly for pumping oil under pressure to burners. It is now made in capacities ranging from 20 gal. per hr. to 100 gal. per min. The 100-g.p.m. pump can be direct connected to a 1,200-r.p.m. motor and operated up to 250-lb. pressure.

The high-speed combined chain hoist and trolley, displayed by Yale & Towne, can lift the bearing point of the hook to within 13 in. below the I-beam in the 10-ton size ($6\frac{3}{4}$ in. for the $1\frac{1}{2}$-ton size).

Cochrane Corporation exhibited the all-glass vacuum-vapor power plant first shown at the New York Power Show, Dec. 5 to 10, 1932, and described in *Power*, Mid-December number, page 352.

For more convenient water treatment, National Aluminate Corporation showed compressed balls combining soda ash, sodium aluminate and other chemicals, balls of various compositions being available for various water analyses. The balls are charged daily into a feeder through which a controllable fraction of the feedwater is bypassed.

Garlock Packing Company showed a new line of composition packing cups designed to replace leather cups, particularly under severe operating conditions.

New units displayed by the Republic Flow Meters Company included a new design of flush-type instrument board with octagonal recorder case and black and aluminum finish. With this was shown a new draft gage.

Among new propeller-type fans displayed by the Bendix Corporation were units for ventilation and for forced draft. Fans in sizes 16 in. to 36 in. are made in 2- and 4-blade models with tapered blades drop-forged from aluminum alloy. A 60-in. induced-draft fan here shown for the first time has stainless-steel blades, heat-treated to withstand temperatures up to 1,100 deg. F. The all-welded, double-wall gear box is water cooled.

In all, ninety firms exhibited, independently or in combination with others.

Corrections to Diesel Data

Section II, June *Power*

● FOLLOWING publication of the Table of Typical Diesel Installations and the accompanying lists of diesel engine and accessory manufacturers, in the June number, several corrections and additions have been called to the attention of the editors. The engine installation of the Clay County Ice Co., Corning, Ark., shown as 120-hp., should instead be listed as a 130-hp. Venn-Severin, 2-cyl. engine, driving an Ideal flywheel generator with V-belt driven exciter. The Standard Diesel Engine Co. of California has just changed its name to the American Diesel Engine Co. Union Iron Works, Erie, Pa., should be listed as a manufacturer of waste-heat boilers and similar heat exchangers rather than as a builder of storage tanks. Morton Mfg. Co., Muskegon, Mich., does not manufacture waste-heat equipment commercially, but has made several interesting installations in its own plant. Under the classification "Filters, Oil," Michigan Products Corp., should instead be Michiana Products Corp., Michigan City, Ind. Acheson Oildag Co., Port Huron, Mich., does not make greases, as listed, but makes a colloidal graphited oil for diesel engine lubrication. Lubriplate Corp., 20 Exchange Place, New York City, should not be listed under "Lubricators" but rather under "Lubricants." Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., should be included under the listings of "Meters, Temperature Indicating and Recording," "Thermometers," and "Valves." Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., should also be listed under "Meters, Temperature Indicating and Recording," "Pyrometers" and associated classifications. Eagle-Picher Lead Co., Cincinnati, Ohio, should be included under "Bearing Metal."

STOCKHOLM WELCOMES THE WORLD POWER CONFERENCE

WHILE American engineers concentrated their attention on Chicago in the last week of June, power engineers of many countries assembled in Scandinavia for the 1933 sectional meeting of the World Power Conference. After the official reception and opening events at Copenhagen on June 26 and 27, technical sessions were carried on in the House of Parliament, Stockholm, from June 28 through July 4. There were study tours and excursions in Sweden and Norway, with ample opportunities to view the scenic beauties of these countries and enjoy the hospitality of their citizens.

The technical program, which included more than 200 papers from many countries, gave much attention to the problems of power in industry. The International Congress on Large Dams held independent sessions to study problems of dam construction.

A brief resume of the program and a list of the American delegates, headed by O. C. Merrill, chairman of the American committee, appeared on page 290 of the June number of *Power*.

The following brief abstracts of selected papers cover points of practical interest to many engineers in this country.

Among the hundreds of papers presented at the Conference meeting, some of the most valuable, from the standpoint of American engineers, were in Section 1*a*, "Electrical Energy," dealing particularly with the supply of energy to large-scale industries and its applications therein.

Steam from Canadian Hydro

Utilization of secondary hydro-electric power for the generation of process steam in Canada was discussed at length in a paper by John Morse and F. T. Kaelin, of the Shawinigan Water & Power Co. The water power now developed in Canada exceeds 7,000,000 hp. Total water-power resources available 95 per cent of the time exceed 20,000,000 hp. and nearly 34,000,000 hp. for 60 per cent of the time. The substantial development of hydro for prime power purposes makes a considerable amount of secondary power available as a by-product.

Certain territories, particularly in eastern Canada, are well adapted to electric steam-generator installations due to comparatively high-cost fuel, the presence of a number of paper mills, chemical plants and other users of process steam in large quantities. Moreover, some of these mills are close to generating stations and large blocks of secondary power can be delivered to them at a low transmission cost.

The rate obtainable for electric power utilized in steam production is based principally upon the equivalent cost of the displaced fuel. However, lavor-saving is an additional consideration and maintenance of electric steam generators is considerably less than for fuel-fired units. Another factor, in certain types of manufacturing, is greater cleanliness of operation.

Years of experience have fully demonstrated the reliability of the elcetric steam boiler. The electric steam-generator load, being of the resistance type, is desirable from the point of view of system power factor.

The widely used electrode-type boiler employs the water itself as an electric resistor. One or more electrodes are immersed in water contained in a single steel shell or in separate steel shells. Voltages as high as 22,000 may be used and capacities up to 50,000 kw. per unit are reached. The installed capacity of electrode-type generators in Canada now exceeds 1,200,000 kw., of which 82 per cent is in the pulp and paper industry, 9 per cent in buildings (for heating), 8 per cent in the chemical industry and 1 per cent in the textile industry.

At 100 per cent efficiency, one kilowatt-hour would produce 3.52 lb. of steam from and at 212 deg. F. The production of 1,000 lb. of steam from and at 212 deg. F. at 100 per cent efficiency would then require 284 kw.-hr. To replace one ton of 13,000-B.t.u. coal burned at 80 per cent efficiency requires 265 kw. used continuously for 24 hours.

The cost of installing electric steam generators, complete with steam and water piping and electrical connections but not including transformers and high-voltage connections, is approximately $3 per kw. capacity for a 5,000-kw., 2,200-volt, single-tank unit, $2 for a 10,000-kw., 2,200-volt, single-tank unit, and $1.30 for a 35,000-kw., 6,600-volt, triple-tank unit. The installed cost of step-down transformers with high-voltage connections will range from $5.00 per kw. for the small-size installations to $1.50 per kw. for larger size equipment.

National Economy Harnesses Steam, Diesel and Hydro

A paper by R. Balmer and colleagues of Sulzer Bros., Winterthur, Switzerland, presented a logical analysis of a national scheme of economical power generation, viewed from the angle of Swiss conditions. A summary of the conclusions follows:

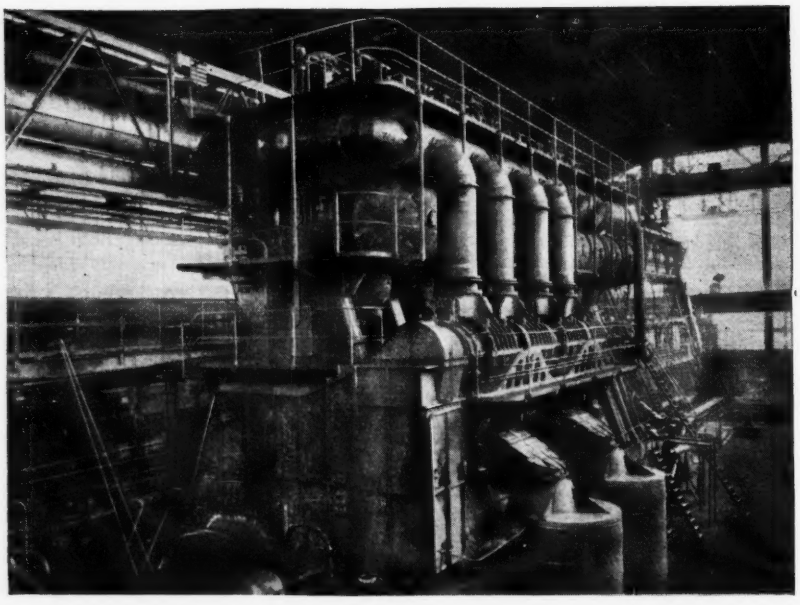
Base loads are generally best taken care of by low-head run-of-river plants. High-head hydro plants with water storage are most suitable to deal with the bulk of the variable part of the daily load. Diesel power stations are most appropriate to cope with substantial peak loads.

The economic efficiency of water storage can be improved considerably by incorporating one or more high-head pumping units into the equipment of the respective power stations; in addition, the economic efficiency of the run-of-river power stations, supplying the energy for pumping, is improved.

With the aid of diagrams giving load as a function of load factor, the total load can be split into parts, according to individual costs, first in the combinations: low-head run-of-river power station; high-head power station with storage; diesel power station; secondly, in the combinations: low-head run-of-river power station; high-head power station with storage and pumping equipment; diesel power station.

Diesel power and pumping are the most practical means available today for improving the economic efficiency of power-supply systems and for making them less sensitive to operating disturbances and prolonged scarcity of water.

The new 22,500-hp. diesel engine installed in the H. C. Oersted power station in Copenhagen, largest diesel thus far built



Interconnection of Steel Mills and Central Power Stations

A paper by W. Martini outlined the conditions surrounding interconnection of steel mills and central power stations in Germany. His principal conclusions are:

Completely electrified steel and rolling mills without blast furnaces generally find it most economical to purchase all power.

Mills with blast-furnace plants require local power generation to make economical use of the blast-furnace gas. There is generally an excess of gas even where neighboring coke ovens are heated by it, because of the production of coke-oven gas. The daily fluctuations in the demand of electric energy and in production of and demand for gas are small with continuous day-and-night operation. A gasholder can easily compensate for these variations.

The big central power stations attach great value to the connection of metallurgical works, as such customers provide a good base load during many hours. Only in exceptional cases is energy being supplied from individual steel plants to the big power stations.

Blast-furnace plants, usually linked up with mines, frequently install their own transmission systems.

Power for Aluminum

The economic relation of power to the production of aluminum in the United States was analyzed in a paper by T. J. Bostwick, chief electrical engineer, Aluminum Company of America. To produce one ton of aluminum, said Mr. Bostwick, requires four tons of ore and 20,000 kw.-hr. This enormous energy demand requires extremely low-cost current and, in general, the location of the reduction plant close to the source of power.

The production of aluminum in excess of market requirements, during periods of depressions, utilizes hydro-electric energy which might otherwise be wasted. Storage of this metal until periods of peak demand defers the heavy investment required for increasing power capacity sufficiently to meet the maximum demand of a fluctuating market.

Practically all of the large waterpowers remaining to be developed in the United States, except those of the St. Lawrence River, are located in such a rugged and inaccessible terrain as to preclude the establishment of reduction works at or even near the power sites. Thus, long-distance transmission becomes a significant and costly factor. Steam-electric power appears as a new and persistent contender for the aluminum-producing business.

Roller Bearings Recommended for Large Electric Machines

The advantages of roller bearings for large electric machines were summarized in a paper by Arvid Palmgren, of Sweden. Some of his conclusions are that when plain bearings are used, machine breakdowns are frequently caused by bearing failure, one of the possible causes being unsatisfactory lubrication, with consequent hot running. Another is wear that is so far advanced that the rotor rubs on the stator, possibly damaging the windings. Melting of the bearing metal owing to hot running is also certain to make the bearings stick.

With roller bearings, the conditions are different. Failure is gradual, first appearing as local "scaling" on the surface of bearing rings or rollers. This does not noticeably affect the running of the bearing or the centering of the rotor, but can easily be detected by ear, particularly with the aid of a stethoscope. If running is continued after scaling has set in, the scaling will spread and will eventually cause the machine to run unevenly and noisily. During the whole of this development period, the centering of the rotor will be practically unaltered.

There is thus ample warning, and the faulty bearing can be replaced by a spare, whereupon the machine is immediately in proper condition.

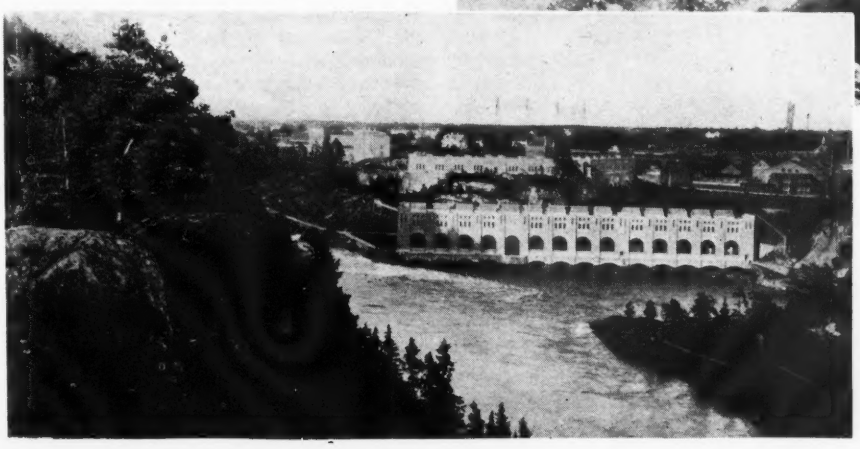
It is clear from studies that have been made that there ought to be no objection to a widespread use of roller bearings even in heavy power machinery upon which the most stringent demands are made in respect to service reliability over a long period.

High-Pressure Steam versus Diesel for Ship Operation

The problems of marine motive power differ from those of land stations in many respects. Notably, questions of weight and space are far more important at sea where plant and fuel must be transported, with resulting limitations on pay cargo and single-fueling radius.

In this connection the seesaw between steam and diesel has been interesting. For a time the diesel engine seemed to have a distinct superiority in over-all economy. This situation now is changed, according to comments made by Dipl.-Ing. Abendroth, of the Siemens-Schuckertwerke of Berlin. He told of the performance of the Benson boiler in the steamer *Uckermark*.

From comparative studies, he concluded that space and weight requirements are even less than for diesel drive. Maintenance costs have been much lower. By the use of cheap waste oils, fuel costs are considerably reduced. The author concluded that for medium- and large-size installations, high-pressure steam is the most desirable ship drive.



Courtesy Swedish State Railways

Forshuvudforsen hydro plant on the Dal River, Sweden, has one 10,200-hp. Lawaczeck and two 7,700-hp. francis type units; head 34 ft. (*Power*, June 4, 1929)

Trollhättan, largest hydro plant in Sweden, is on the Göta River, is 47 mi. from Gothenburg, has 13 main units, totaling 197,000 hp., head 100 ft. (*Power*, June 21, 1932)

Courtesy American-Swedish News Exchange

ATTENTION FOCUSED ON TEST METHODS BY A.S.H.V.E. in DETROIT

Circular slide rule for finding pipe sizes in a hot-water system; comparison of air-change and distribution methods; instrument for measuring performance of direct radiators; testing convectors in a warm-walled booth, air-cleaning device and effects of artificially ionized air on human beings among subjects considered

HEATING and ventilating engineers convened at Detroit for the semi-annual meeting of the American Society of Heating and Ventilating Engineers, June 22 to 24. Among the papers presented at the three technical sessions, some of interest to *Power* readers are briefly abstracted. Although the papers were of considerable value to the heating industry there was little discussion at any of the sessions.

A paper of practical value to the heating-system designer was that presented by L. A. Cherry, which described a circular slide rule for determining the sizes of pipes and restricting orifices in a hot-water heating system. The "Pipe Sizer" is based on data resulting from the researches of Prof. F. E. Giesecke on hot-water heating systems. The chart is arranged so that with a known load either in thousands of B.t.u. per hour or equivalent square feet of heating surface, and any desired temperature drop through the radiators the total friction of pipe, fittings and orifices may be read directly. Pipe sizes for a complete hot-water heating system, arrived at by using the "Pipe Sizer," are given in the paper.

In discussing the paper, Prof. Giesecke pointed out that the difficulty of making calculations for hot-water heating system pipe sizes was one of the reasons this system of heating is not used more frequently, and that the new chart should go a long way towards helping this situation.

For use in the preparation of the Code of Ventilation Standards, the A. S. H. V. E. Laboratory made a comparison of various methods of measuring air change and distribution in ventilated space, results of which were presented in a paper, "Indices of Air Change and Air Distribution," by F. C. Houghten and J. L. Blackshaw.

An occupant of an inclosed space changes the physical and chemical composition of the air by increasing its sensible-heat; moisture, and, therefore, latent-heat; and the CO_2 content. Each of these changes was investigated to determine its practicability as a means of calculating the number of air changes.

Greater consistency was shown among individual determinations of air change made by the moisture-content method than the CO_2 method.

Measurement of air change in a room by moisture determination with a sling psychrometer can be made more quickly, and with much greater ease, than by the lengthy and complicated CO_2-analysis method. Since the accuracy of the wet and the dry-bulb method is as great or greater than that obtained through the use of CO_2, it is recommended as the more desirable method for making air change determinations.

Following the presentation of this paper, A. P. Kratz related his experience in attempting to measure air changes in the research residence by measuring condensation formed on the cooling coils of the air-conditioning equipment. The method proved satisfactory for summer months, but during winter months the results were unreasonable due to moisture from basement walls.

Other discussions also suggested that absorption of moisture by walls would make the measurement of air change by the change in air-moisture method unreliable. Mr. Houghten replied that the actual error due to moisture absorption by walls was small and that the difficulty of making delicate CO_2 determinations made the air-moisture method preferable.

In previous tests on direct radiators, room temperatures were measured by means of thermocouples. It was desired to know whether any modification in the conclusions would result if a sizable instrument, more nearly approximating the proportions of the human body, were used as an index of the combined effects of radiation and convection, instead of the comparatively small thermocouples.

An instrument of this nature, called a eupatheoscope, had been developed by the Building Research Board in England. The principle underlying this instrument involves the measurement of a heat loss from a sizable body when the surface is maintained at some constant temperature. The main element of the eupatheoscope used in the tests, reported in the paper by A. C. Willard, A. P. Kratz and M. K. Fahnestock, consisted of a hollow copper cylinder 7½ in. in diameter and 22 in. long, placed vertically on a stool, so that its mean height was 30 in. above the floor. Twelve thermocouples were embedded flush with the surface of the cylinder, which was painted black, from which the surface temperature was determined. To heat the surface of the cylinder, a lamp-bank was placed inside and means provided for measuring the electrical input to it.

Comparison of radiator and convector performance tests made with thermocouple temperature taken at the 30-in. level, and eupatheoscope readings were reported in the paper. These tests indicated that the eupatheoscope affords a means of evaluating the combined effect of radiation and convection in a given environment, in terms of a standard environment, and in some terms related to human comfort. The readings of the eupatheoscope serve as a means of arranging various heating units in order of the relative heating effect produced. Steam condensation obtained, when the equivalent temperature is maintained at 68 deg. F., at the 30-in. level, is an approximate measure of the effectiveness of different types of heating units in providing human comfort.

In the discussion it was pointed out that when determining the comfort conditions of an environment the Kata thermometer takes account of dry-bulb temperature, relative humidity and air movement, while the eupatheoscope disregards relative humidity and substitutes radiation. A question was raised as to whether black was the proper color to paint the instrument, but the author felt this approaches quite closely the emissivity of normal clothing.

The A.S.H.V.E. Code for Testing and Rating Concealed Gravity Pipe Radiation contains a correction factor for reducing the heat output obtained under testing conditions equivalent to the heat output under standard conditions. Work undertaken at the University of Illinois to establish the accuracy of this correction factor when used with convectors, and the results, were reported in a paper by A. P. Kratz, M. K. Fahnestock and E. L. Broderick.

The results in general indicate an agreement with the correction factor within 5 per cent between the heat output actually obtained under standard conditions of steam at 215 deg. and inlet air at 65 deg., and that calculated from the heat output at some other inlet air temperature, provided that the inlet air temperature does not exceed 80 deg. F., or fall to below 60 deg. F. The magnitude of error is influenced by the type and physical dimensions of the convector.

Testing and rating of air-cleaning devices were discussed in a paper by Samuel R. Lewis. A description of the apparatus for testing air-cleaning devices was given in the paper, together with points concerning its use.

The result of an investigation into the physiologic effect of artificially ionized air on human subjects was reported in a paper by C. P. Yaglou, A. D. Brandt and L. C. Benjamin. Although physiologic response to positive and negative ions did not seem to differ greatly, nevertheless, positive ionization resulted in headaches and irritation in the nose and throat in some cases, whereas negative ionization predisposed to relaxation and other sensations of a desirable character.

Resolutions were adopted at the meetings to eliminate the use of the term equivalent square feet of radiation now used in rating radiators and to substitute a commercial heat output unit of 1,000 B.t.u. per hr., to be represented by the symbol M.B.h.

Characteristics of the

TWIN-SET HELL GATE BOILERS

By W. E. CALDWELL
United Electric Light & Power Co.

Results of tests showing flexibility, efficiency and starting up performance of a 1,000,000-lb. per hr. sectional-header, end-to-end boiler at Hell Gate are given in this paper, presented at the Spring Meeting of the A.S.M.E., Chicago, June 26 to 30, 1933.[1]

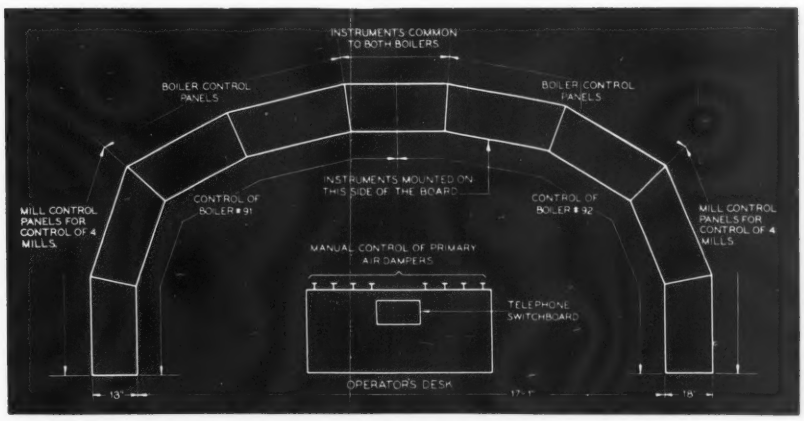

INSTRUMENTS COMMON TO BOTH BOILERS
BOILER CONTROL PANELS
BOILER CONTROL PANELS
INSTRUMENTS MOUNTED ON THIS SIDE OF THE BOARD
CONTROL OF BOILER # 91
CONTROL OF BOILER # 92
MILL CONTROL PANELS FOR CONTROL OF 4 MILLS
MILL CONTROL PANELS FOR CONTROL OF 4 MILLS
MANUAL CONTROL OF PRIMARY AIR DAMPERS
TELEPHONE SWITCHBOARD
OPERATOR'S DESK

Fig. 1—Boilers and auxiliaries controlled from central board

THE boiler room addition[2] to the Hell Gate generating station contains the two largest pulverized fuel-fired, slag-tap furnaces so far installed. Each furnace serves twin sectional-header boilers, arranged end-to-end in a single setting. An additional feature of the installation is a unit capacity in excess of 1,000,000 lb of steam per hour. The building housing these boilers in 78.7 ft.x106.5 ft.x162 ft. high; the ratio of building volume to steaming capacity is 680 cu. ft. per 1,000 lb. per hour. Correcting the building volume for space devoted to railroad tracks and court entry reduces the ratio to 636 cu. ft. per 1,000 lb. of steaming capacity per hour.

In the absence of space for an ash hopper of the dry-bottom type, the flat-bottom type of furnace became almost a necessity. Earlier problems with slagging furnaces at Sherman Creek Station had been experienced, and this pioneering work left little doubt as to the attractive possibilities of the system.

The four mills and their auxiliaries are directly below each furnace, while the forced- and induced-draft fans are immediately above the air heaters.

Coal bunkers are located below the fan platform, from which coal is fed by gravity through vertical chutes to the mill feeders. Each chute supplies one mill and is provided with a Richardson automatic scale ahead of the feeder with remote indication at the control board. These scales facilitate accounting and control as well as testing. There are two drag conveyor feeders per mill located on the operating floor and accessible from the control board. The feeders are driven by d.c. motors from motor-generator sets with Ward Leonard speed control.

[1]Published at the request of the American Society of Mechanical Engineers.

[2]Hell gate addition described in *Power*, March 3, 1931.

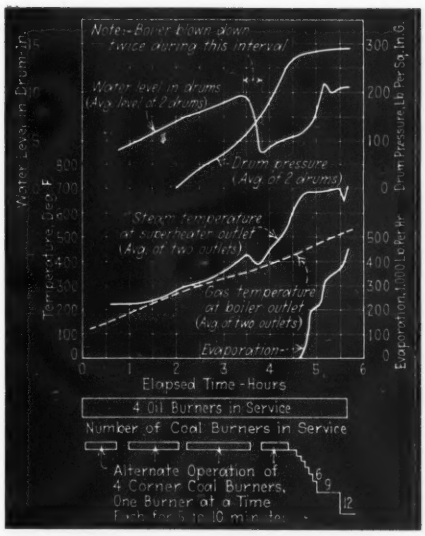

Note:-Boiler blown down twice during this interval
Water level in drums (Avg. level of 2 drums)
Drum pressure (Avg. of 2 drums)
Steam temperature at superheater outlet (Avg. of two outlets)
Gas temperature at boiler outlet (Avg. of two outlets)
Evaporation
Water Level in Drum, In.
Temperature, Deg. F.
Drum Pressure, Lb. Per Sq. In. G.
Evaporation, 1000 Lb. Per Hr.
Elapsed Time - Hours
4 Oil Burners in Service
Number of Coal Burners in Service
Alternate Operation of 4 Corner Coal Burners, One Burner at a Time

Fig. 2—Starting-up data on cold boiler

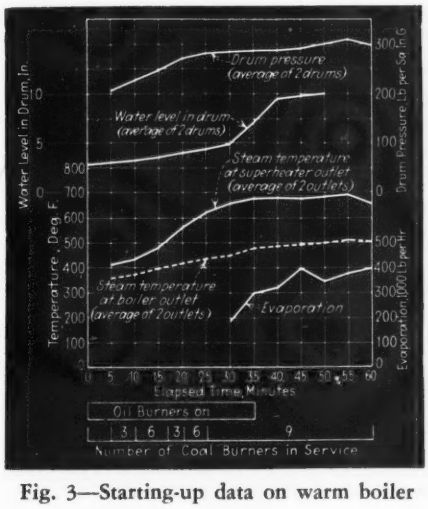

Drum pressure (average of 2 drums)
Water level in drum (average of 2 drums)
Steam temperature at superheater outlet (average of 2 outlets)
Steam temperature at boiler outlet (average of 2 outlets)
Evaporation
Water Level in Drum, In.
Temperature, Deg. F.
Drum Pressure, Lb. per Sq. In. G.
Evaporation, 1000 Lb. per Hr.
Elapsed Time, Minutes
Oil Burners on
3 6 3 6
9
Number of Coal Burners in Service

Fig. 3—Starting-up data on warm boiler

Steam conditions, 275 lb. per sq. in. pressure and 725 deg. F., are the same as those prevailing in the remainder of the generating station.

The end-to-end arrangement of boilers over a common furnace, required that an access space be provided between the headers. This space was sealed from the furnace by bringing the bottom slag screen tubes under the bottom of the high end headers and entering the opposite side of the header by a wide sweep return bend in the tube. This arrangement provides a water-cooled support for the protecting tile beneath the headers and also the baffle between header access space and furnace. The circulation of the two boilers is not interconnected and each supplies its half of the furnace water walls, so that the circulation of each half of the units is entirely independent. The superheater, economizer and air heater of each half of the unit are also independent, although the discharge end of the air heaters is connected to a common plenum chamber. This chamber arrangement renders the installation more independent of induced-draft fan outage, since the unit may develop about 75 per cent capacity with half of the fan equipment idle. The same general practice is applied to the forced-draft connection to obtain the same benefits of diversity and availability. This combination was obtained by a slight inclination of the air preheaters and the elimination of separating partitions.

Aside from innovations regarding the twin arrangement, the boiler and furnace are of conservative design. Heat release rates, absorption rate per unit of surface and gas velocities entering the tube bank are moderate. Water capacity of the boiler and economizer is rather large, and although the resulting accumulator effect renders the unit somewhat slow in response to changes of rating, it has a desirable stabilizing influence with fluctuating loads.

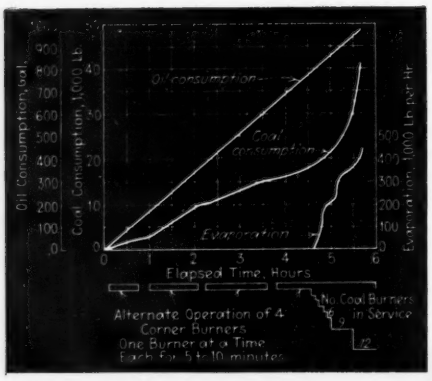


Fig. 4—Fuel consumption during starting-up cold boiler

The 72-in. boiler drums are adequate to permit wide changes in rating without danger of carry-over. Large drum capacity is especially important, with the moderate pressure and relatively high specific steam volumes prevailing, to accommodate the swelling contents of the boiler with wide increase in rating. This removes one of the possible limitations of flexibility and responsiveness, since water level fluctuations are confined within safe limits regardless of the rapidity and range of load change. With adequate drum capacity, the feed control problem is simplified and operating attention is reduced to a minimum.

The visible range within the water glass accommodates a 13 per cent change in volume of water contained in the boiler and water walls at normal water level. This is equivalent to 4.5 per cent of the hourly output at maximum capacity, on the basis of solid water.

Three horizontal circulator tubes per section minimize discharge friction and insure an effective hydraulic head on all tubes. This lessens the likelihood of stagnant circulation, with the accompanying problems, and is of benefit from the standpoint of boiler maintenance and availability. The boiler drum is fitted with shutter-type baffles for moisture separation. Saturated steam is distributed to the superheater by means of a number of off-take tubes distributed along the length of the boiler drum and connected with the saturated steam superheater header. This arrangement assures uniform steam distribution through the entire superheater with minimum pressure drop. The conventional hair-pin economizer and standard tubular air heater are both arranged for counter flow.

Burners and Furnaces

Each mill delivers to three cross-tube burners arranged in a horizontal row across the furnace width, there being two rows at each end of the furnace, one located above the other. This provides well-balanced furnace conditions with almost any combination of mills. Individual burners may be cut out by closing a valve in the top of the mill which diverts the coal and primary air from that burner to the remaining outlets and burners. The mills grind to a fineness of 55 to 70 per cent through a 200-mesh screen. There is an oil burner just below each coal burner for ignition purposes only. The Bailey water-cooled furnaces are, roughly, 41 ft. long between burners, with a width of 34 ft. and a mean height of 30 ft. Furnace volume is 40,770 cu. ft., giving a heat liberation of about 35,000 B.t.u. per cu. ft., at 1,000,000 lb. per hour evaporation.

A centrifugal compressor delivering at about 1 lb. pressure provides air for cooling the furnace bottom. Immediately below the slag bed is an impervious layer of crushed magnesite supported on a porous layer of chrome ore. The cooling air is distributed by transverse ducts in the layer of chrome ore, from which it is discharged into the furnace at the side walls above the slag bed. The quantity of air used for cooling is determined from Bailey air-flow meters which form a part of the regular operating equipment.

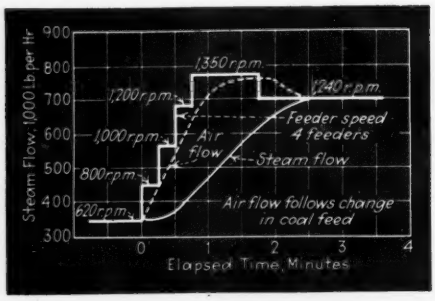


Fig. 5—Time lag in steam flow after 100 per cent change in coal feed, 9 per cent over-travel. Rate of steam flow increase, 140,000 lb. per hr. per min. Increase in header pressure, 11.5 lb.

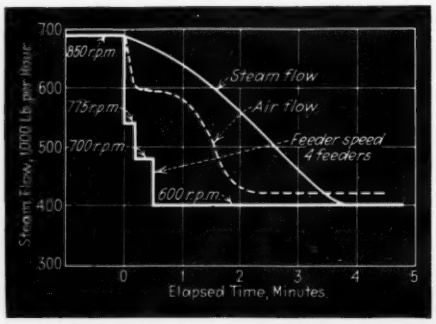


Fig. 6—Time lag in steam flow after 29 per cent decrease in coal feed, no over-travel. Rate of steam flow decrease, 77,400-lb. per hr. per min. Decrease in header pressure, 7.3 lb. Decrease in water level, 5 in.

Moderate preheated air temperature permits normal operation without the use of tempering air and the attendant manipulation required where higher preheat is used. With a direct-fired system, there are many adjustments which must be readily coordinated and in the interest of reliability these were kept to the minimum.

There are four induced-draft fans and two forced-draft fans per boiler unit. The induced-draft fans are connected in pairs and driven through reduction gears by a high-pressure, high-speed turbine, the exhaust steam from which is used to operate the low-pressure turbine driving the forced-draft fan.

Local conditions of plant expansion was a factor in the selection of fan drives. With the existing conditions, differences between various types of drives were small, and turbine drives were chosen for convenience. The exhaust steam from the low-pressure turbines which drive the forced-draft fans is discharged through short connecting piping to a closed heater in the feed-water supply to the boilers.

Controls have been brought to a central location with the necessary instruments and devices provided so that operation is greatly simplified. The control board is illustrated in Fig. 1. Practically all adjustments for starting, stopping and changing the output are made from this control station. Sequence interlock relay protection is provided to guard against flare backs or explosions due to mechanism failures or mishandling.

Figs. 2 and 3 depict graphically the sequence of burner operation followed in starting the boiler from the cold condition and also the method followed after a normal shutdown over the midnight watch. The intent of this method of starting from cold is to apply heat gradually about the furnace so that proper circulation may be established throughout in order to avoid excessive temperature stresses. With the direct-firing arrangement, this necessitates operating the mills for short intervals in rotation and is conveniently accomplished from the central control board. The boilers are started each morning on weekdays, at which time the furnace is hot from the previous day's operation and there has been little loss of steam pressure. Under these conditions, the unit goes on the line within a few minutes after the first burner is lighted.

Capacity and Flexibility

Maximum capacity of the installation is limited by the fans and pressure drop through the superheater. With the average grade of coal used, mill capacity is near the limit when other limiting conditions are approached. The lower limit of output is established by the minimum practical capacity of one mill together with secondary air leakage through the burner dampers of the idle mills. The heat radiated by the hot slag bottom provides strong ignition and minimizes the danger of flare backs with one mill operation or under unfavorable coal feed conditions. The boiler has been operated for sustained periods at outputs as low as 200,000 lb. per hour and as high as 1,080,000 lb. per hour. Under test conditions, these figures could be considerably bettered at both ends of the range by means well known to many operators. However, a more rational basis of rating for daily operation may be considered as from 300,000 lb. per hour to 1,000,000 lb. per hour.

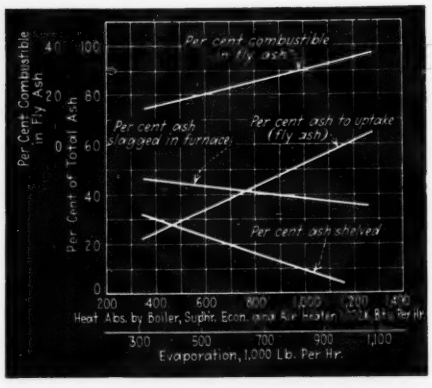

Per Cent Combustible in Fly Ash
Per Cent of Total Ash
Per cent combustible in fly ash
Per cent ash slagged in furnace
Per cent ash to uptake (fly ash)
Per cent ash shelved
Heat Abs. by Boiler, Suphr. Econ. and Air Heater, M Lb. B.t.u. Per Hr.
Evaporation, 1,000 Lb. Per Hr.

Fig. 7—Distribution of refuse in boiler

Tests were conducted under the supervision of manufacturers' representatives to determine the rate of response of the mills for various changes in the feeder speed, together with the time effect on steam output from the boiler. These data are indicative only since it was not convenient to carry out the tests with the precision of an evaporative test nor to entirely eliminate influences tending to effect the result of the observations. Some of these test data are recorded in curves of Figs. 5 and 6. The tests covered both increase and decrease in output with observations recorded on 15-sec. intervals. Time lag between coal feeder change and the change in heat input to the furnace was determined by ascertaining the variation in CO_2 in the flue gas while maintaining a constant supply of primary and secondary air. The change in CO_2 at the boiler outlet commenced within 15 sec. of the start of the change in coal feed and a stable condition was reached in about 2 min. Steam flow started to change 12 to 18 sec. after the change in coal feed and reached a final value in from 2.5 to 4.5 min. The shortest lag was obtained by giving considerable overtravel to coal feeders and adjusting secondary air supply to follow the change in coal supply instead of following steam flow. The most rapid increase in output was 350,000 lb. per hr. in a period of 2.5 min. The rate of the increase was 35,000 lb. of steam per hr. per mill per min., or 140,000 lb. of steam per hr. per min. for the boiler. This increase in evaporation represents 100 per cent change if referred to the load at the beginning of the change and 14 per cent change, if referred to the maximum capacity.

Little change is required in primary air control for the full range of mill capacity, only one or two adjustments for the complete range being necessary. It is probable that a simple automatic control could be provided that would maintain constant air flow independently through the mill for practically all conditions. This would lessen the probability of a mill plugging and would simplify operation. Operating conditions thus far have not warranted this refinement.

Load conditions which necessitated shutting down the boilers every night for about 8 hr. introduced a problem in slag removal. This was somewhat aggravated by occasional receipts of coal having high-fusion ash and the necessity for running a rather high furnace draft to protect the upper seal in the furnace against the furnace stack effect and consequent gas pressure. The high furnace draft greatly inconvenienced slag removal due to the chilling effect of air drawn against the slag stream at high velocity through the slag-tap opening. Chilling of slag necessitated almost continuous use of bars and hooks to keep the slag flowing, and at the expense of much physical labor.

Some improvement was obtained by substituting water-cooled slag liners to which the slag did not adhere so tenaciously. This reduced the labor of clearing the slag spout but still required, with normal grades of fuel, the constant presence of attendants to insure continuous flow. Tests were made with fluxes, and some improvement in slag removal resulted. The fluxes, however, did not seem to combine chemically with the ash but appeared to form an insulating scum on the surface which protected the underlying slag against the chilling effect of the inrushing air. The method of introducing fluxes was rather crude, but the benefit appeared to be physical rather than chemical. This also seemed to be borne out by the fact that fluxes which should be expected to have little effect in depressing the melting point appeared to have a pronounced influence in preventing chilling of the slag stream.

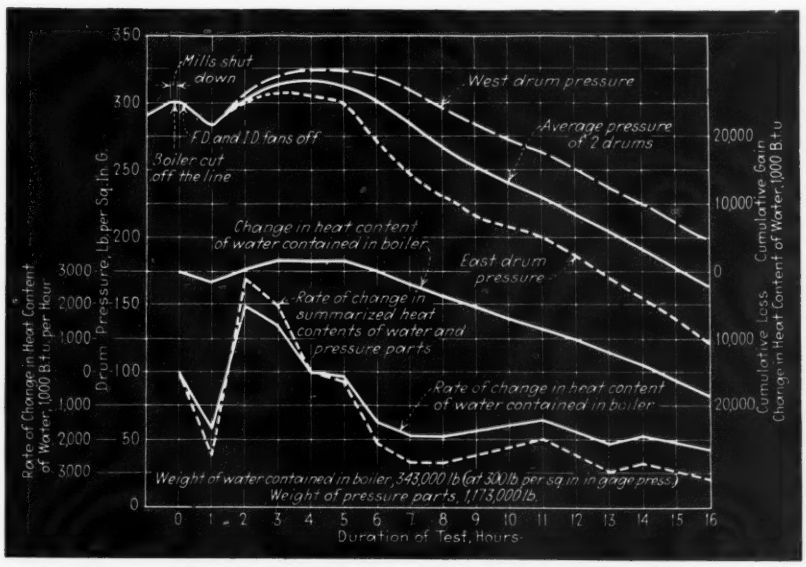

Mills shut down
West drum pressure
Average pressure of 2 drums
F.D. and I.D. fans off
Boiler cut off the line
Change in heat content of water contained in boiler
East drum pressure
Rate of change in summarized heat contents of water and pressure parts
Rate of change in heat content of water contained in boiler
Weight of water contained in boiler, 343,000 lb (at 300 lb per sq. in. gage press.)
Weight of pressure parts, 1,173,000 lb.
Duration of Test, Hours
Drum Pressure, Lb. per Sq. In. G.
Rate of Change in Heat Content of Water, 1000 B.t.u. per Hour
Cumulative Gain Change in Heat Content of Water, 1000 B.t.u.
Cumulative Loss

Fig. 8—Drop in drum pressure used to indicate loss by radiation

As a final corrective measure, one slag opening and its receiving chamber were encased. By inducing draft in this chamber greater than that existing in the furnace, hot gas from the furnace is withdrawn with the slag instead of permitting cool air to exert a counter-current effect on the slag stream during its passage. This resulted in marked improvement in the slagging operation, eliminating the frequent use of hooks and shortening the time required for slag removal. With this improvement, slag which is fluid enough to approach the opening may be readily withdrawn.

Cooling Rate

The boilers have a low radiation loss due to tight well-insulated settings with slag bottoms and tight-fitting uptake dampers. Observations made during a winter shutdown, with low ambient temperature conditions prevailing, are reproduced in Fig. 8. Decline in pressure has been used as a measure of radiation, and while this is not a strictly accurate method it is an indication of relative value for comparison purposes. The pressure in one of the boilers of the unit declined more rapidly than the other due to the fact that damper leakage on that half was somewhat greater. On shutting down, there was a slight delay in closing the dampers, after which it may be noted the pressure in the boiler increased due to absorption of heat from the hot slag bottom.

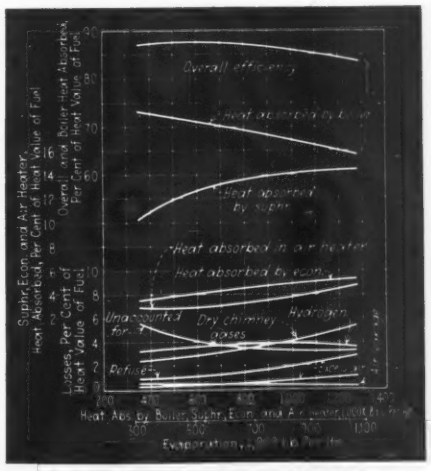


Fig. 9—Tests show over-all efficiency of 88 per cent

After about six hours, the rate of change in heat content of water contained in the boiler became nearly constant and this may be regarded as a rough indication of the radiation rate. It is equivalent to about 0.2 per cent of the heat input at maximum capacity. This method of accounting presupposes water temperatures throughout the boiler corresponding to the pressure and includes the water equivalent of the metal parts in contact with the boiler water. Undoubtedly, a large proportion of the heat loss is due to unavoidable infiltration and damper leakage, and it is probable that the not slag bed acts as a heat accumulator in reducing the rate of pressure loss in the boilers. This characteristic is advantageous, since it simplifies starting the boiler after an overnight shutdown.

Primary air fans are located on the inlet side of the mills, which operate under pressure. Fan air supply is taken from the main air duct and protected against possible backflow by light unbalanced non-return dampers. In addition, the primary air supply pipe is extended vertically a substantial distance within the air duct so that it does not communicate with any portion of the plenum chamber adjacent to the burner openings into the furnace. As an additional precaution a balanced relay is provided to cut out the mills and other apparatus in the event the furnace pressure exceeds the air duct pressure for an appreciable time interval.

Curves shown in Fig. 7 give, in graphic

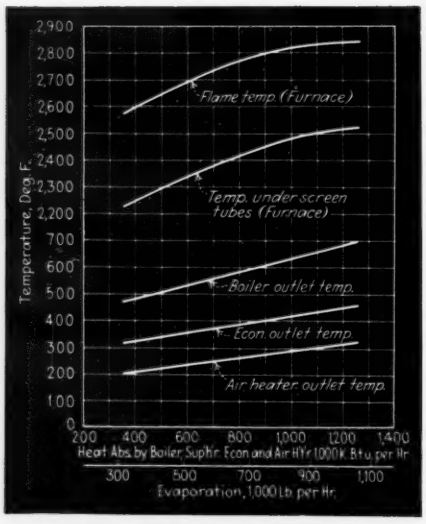

Flame temp. (Furnace)
Temp. under screen tubes (Furnace)
Boiler outlet temp.
Econ. outlet temp.
Air heater outlet temp.
Temperature, Deg. F.
Heat Abs. by Boiler, Sup'ht. Econ and Air Htr. 1000 K. B.t.u. per Hr.
Evaporation, 1,000 Lb. per Hr.

Fig. 10—Gas temperatures in boiler economizer and air heater

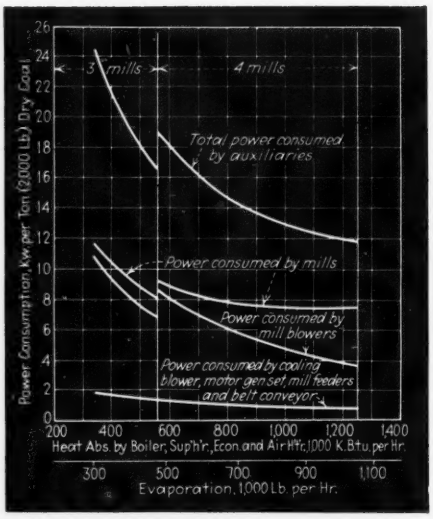

3 mills
4 mills
Total power consumed by auxiliaries
Power consumed by mills
Power consumed by mill blowers
Power consumed by cooling blower, motor gen set, mill feeders and belt conveyor
Power Consumption, Kw. per Ton (2000 Lb.) Dry Coal
Heat Abs. by Boiler, Sup'ht'r., Econ. and Air Htr. 1000 K. B.t.u. per Hr.
Evaporation, 1,000 Lb. per Hr.

Fig. 11—Power consumption of mills, mill blowers and coal feeders

form, the approximate relationship between the three components of total ash at various ratings. "Fly ash to uptake" was determined at all ratings by measurement. The other two components were determined on the following basis: for low ratings the "ash slagged in furnace" was estimated as 45 per cent, this figure being substantiated by the experience of the manufacturer, and the "ash shelved" component was determined by difference: for the high ratings it was observed that the "ash shelved" component was zero due to high gas velocity and the "ash slagged in furnace" component was determined by difference. Although the "ash shelved" component could not be accurately measured, its content of combustible was determined from the samples taken from various baffles. The content of combustible in the fly ash to uptake was determined by measurements, and the ash slagged in the furnace bottom was assumed to contain practically no combustible.

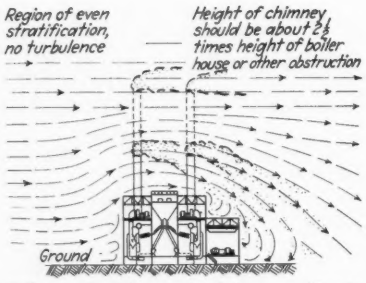
Results of the evaporative tests are given in curve form. Fig. 9 shows the heat balance and over-all efficiency, which reached 88 per cent. Fig. 10 contains curves of gas temperature and fig. 11 shows the power consumption of mills, mill blowers and coal feeders.

The author gratefully acknowledges the assistance rendered by his associates and manufacturers' representatives in preparation of this paper.

SMOG—and what's being done about it

WITH few exceptions, cities that have anti-smoke ordinances regulate only dense smoke; solids that do not color the smoke stream and noxious and obnoxious gases are not regulated. Generally, unless density is such that it is impossible to see through the column of smoke as it leaves the stack, there is no violation. Speaking recently on community campaigns against air pollution, H. B. Meller, head, Air Pollution Investigation, Mellon Institute of Industrial Research, explains that much of the slackness in combating smoke and flue dust precipitation has been due to the general belief that smoke and prosperity are inseparably connected. Further, home owners have been ready and willing to attack power plant smoke emission, but most unwilling to have their own firing practices and heating plants similarly attacked. Further, smoke regulation is usually a community affair, and smaller industrial areas outside the central community continue without regulation. This of course to a certain extent nullifies the work of the central community. Mr. Meller suggests district regulation, and gives limits for ordinances. By this means, he says dense smoke can be eliminated and light smoke can be controlled within reasonable limits. Surveys are required by competent mechanical engineers, and these will probably indicate that much of the smoke pollution can be eliminated by installation of new equipment or repair and modernization of equipment which has suffered from undermaintenance during the past three years.

Large power plants have in many cases gone to extraordinary ends to curtail smoke and flue dust emission. Classic examples are the 540-ft. stacks of the Leipzig-Norde generating station. H. E. Wallsom, speaking before the Institute of Fuel (British) recently, explained that this station is located in the center of a very high-class residential quarter of the town and burns a poor grade of brown coal. Realizing the danger of smoke precipitation and consequent lowering of adjacent property values, the designers planned high stacks and even added electrostatic precipitators to insure that the station would not become a nuisance, either through emission of smoke or sulphur. According to Mr. Wallsom and J. W. Gibson, chimney height should be about two and a half times the height of the boiler house or other obstruction in order to insure that the dust and fumes are dispersed over so wide an area that their effect would not be noticeable. At lower elevations, eddy currents in the air cause dust and fumes to be precipitated in a relatively small area.


Region of even stratification, no turbulence
Height of chimney should be about 2½ times height of boiler house or other obstruction
Ground

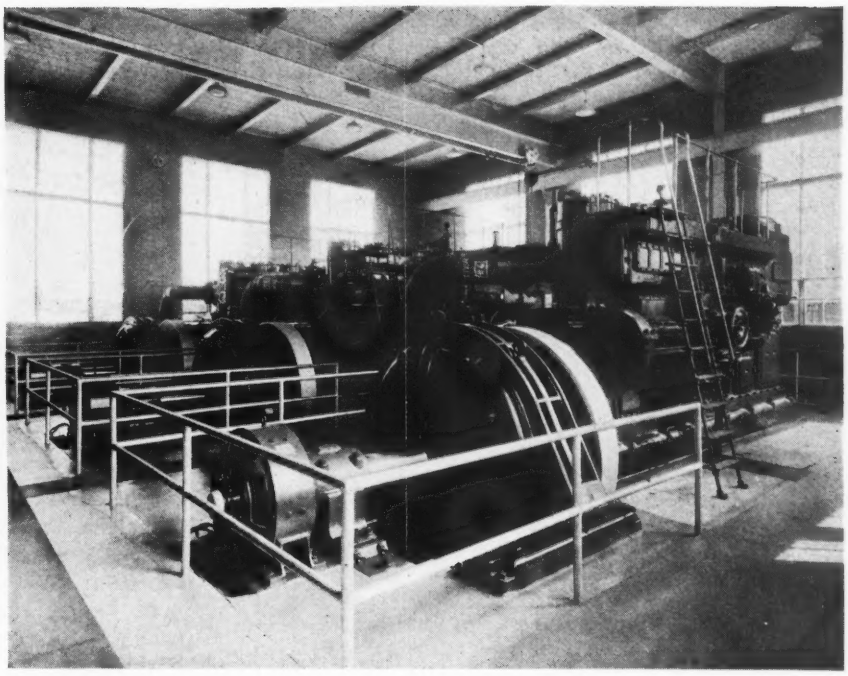
Effect of chimney height on distribution of sulphur fumes near a power station

Mr. Wallsom concludes that, considering their fairly low initial cost, wet systems will give the greatest degree of commercial efficiency. Centrifugal collectors, while they definitely alleviate the trouble, are not so efficient as other systems. With electrical and wet systems, it is desirable that the velocity of the flue gases should be reduced to 6 ft. per-sec. to insure retention of the finer dust particles. In wet systems, especially where recirculation is necessary, the use of unprotected steelwork is undesirable because of acid corrosion, and it may be desirable to increase gas velocity through the system in order to minimize this difficulty. Velocity of gases in the stack should be sufficient to prevent deposition of wetted dust from washing systems at the top of the stack or on adjacent roofs. Where wet washing is favored, lead linings for washing chambers and stacks is preferable to concrete, as concrete is liable to rapid deterioration by acid action. Wooden washing chambers may possibly overcome many difficulties in this direction.

Mr. Wallsom disparaged injection of steam into flue gases, because flue gas temperatures are too high for the steam to form a mist, and even if they were so low as to permit this, the result would be a muddy deposit immediately about the stack.

Instruments and apparatus for smoke density determinations are summarized and explained in Part 20 of the A.S.M.E. Power Test Codes, series 1933, which was approved by the Power Test Codes Committee June 2 and will be presented to the A.S.M.E. Council for final approval sometime this fall. This report classifies and lists the various types of instruments and indicates the relative efficiencies and uses of the various types. Copies of Part 20 can be obtained by addressing the American Society of Mechanical Engineers at 29 West 39th St., New York, N. Y.

Possibilities of waste heat utilization with 2-cycle diesels are not as great as with 4-cycle units, because exhaust temperatures are lower and because utilization may interfere with scavenging. Here are reported, however, as the second article of the series on waste-heat recovery, results at the Bloomington, Ill., municipal plant



Recovering Diesel Waste Heat at Bloomington

By LLOYD HOWELL
Heating Engineer

PLACED in service Aug. 15, 1932, the municipal power plant of Bloomington, Ill., furnishes electricity to the City Water & Light Department, which serves a population of about 30,000 with water and with lighting for streets and public buildings, and in addition some 1,000 customers. Three 750-hp., 2-cycle diesel engines with direct-connected generators, all auxiliary equipment and up-to-date accessories, including an overhead crane, are housed in the 60x60-ft. building. Oil storage tanks are in a nearby yard. (Full statistics, section 2 of *Power,* June.)

C. C. Williams, superintendent of the City Water & Light Department, directed construction of the plant and engaged the author to make a study of possible waste-heat utilization. He it was who roughed out the plan finally adopted and who supervised installation and test of the equipment.

After completion of the diesel plant proper, there arose the question of heating the building during the winter months. The writer was engaged to report with plans and specifications for apparatus designed to maintain the indoor temperatures at a reasonable figure during the heating season, which, in this latitude, begins late in September and extends over a period averaging 5,000 hr. annually to early in May. The lowest temperature recorded by the U.S. Weather Bureau is 24 deg. below zero F., and the average of all temperatures during the heating season is about 35.5 deg.

At the outset it was apparent that the design of the building would assure ample means for relieving excess temperatures by means of natural ventilation through controlled vent openings provided. It was then decided that a system capable of maintaining an indoor temperature of 50 deg. during an outdoor temperature of 10 deg. below zero F. would provide enough heat.

Based upon this 60-deg. temperature rise, the maximum hourly heat loss of the building only, without including heat generated by the machine equipment, was calculated to be 475,000 B.t.u. Total space to be heated comprised approximately 100,000 cu.ft., consisting of a basement story (having a large open stair-well to the first floor) and a main story, including an adjoining switchboard compartment with an open framework above, opening into the engine room.

The effect upon the building temperature of heat radiated from machine equipment during operation was then considered. This amount obviously would vary in some proportion to the electrical load carried by the plant. After considerable investigation, a somewhat arbitrary value was selected for this radiated heat, and it was assumed that some of this heat would be present at all times. Rather than reduce the figure for maximum hourly capacity, it was decided to retain this at full calculated value and to include radiated heat only in calculation of operating costs. The value for radiated heat was placed as equivalent to shortening the average annual heating period to 4,000 hr., or a reduction of 20 per cent in time.

Various types of system were considered for comparison with a heat-recovery installation, such as a steam

system from an independent boiler, steam system from waste-heat boilers, hot-water system from an independent boiler, hot-water system from engine jacket water, electric heaters for air with fan distribution, and finally a warm-air fan system. This latter consisted of an oil-fired, cast-iron sectional furnace with motor-driven centrifugal blower for air distribution. This system presented lower investment and operating costs and was conveniently applicable to this particular building, so was selected for detailed comparison with a heat-recovery system. This is the cost set-up:

Interest on investment, @ 5%	$ 60
Depreciation, @ 5%	60
Maintenance, @ 1%	12
Fuel Oil, @ $0.05c per gal.	375
Electric Current, @ 1c. per kw.-hr.	74
Total Annual Cost	$581

(Oil and electricity costs are based on figures somewhat higher than obtain at this plant today, but the difference is not enough to invalidate the selection finally made).

From available records, it seemed proper to figure that an engine consumption of 25 gal. of oil per hr. would liberate 3,643,250 B.t.u. and produce power for an average daily load of 272 kw., or approximately 440 hp. Then, recovery of 5 per cent of the total heat of the oil would balance the average hourly heat demand, while recovery of about 13 per cent would take care of the maximum hourly heat demand.

Assuming that one of the three engines would handle the average load, with the other two engines idle, it was decided to install separate heat-recovery units on each engine. These could, if necessary, operate in combination. Calculations were accordingly made for three blower units, one for each 14-in. exhaust pipe, so designed that they could be installed without disturbing piping already in place or necessitating removal of any engine from service.

Each unit consists of a motor-driven centrifugal blower with air intake near the basement floor, discharging to an air duct completely enclosing the engine exhaust pipe and silencer. This forms a jacket envelope for the air, which in passing through picks up heat from the hot exhaust. Heated air is delivered to the engine room through overhead controlling and diffusing openings. The heated air entering the room causes cooler air to fall toward the basement floor, where it is picked up by the fan intake to repeat the cycle.

Engine-room dampers are handled by cord pulls instead of chains or rods because of their proximity to the switchboard. Those portions of the air-duct envelope outside the building are heavily lagged with 2-in. asbestos air-cell insulation, covered in turn with galvanized sheet. Silencer envelopes are lagged with insulating panels, removable for cleaning the silencers.

An air-relief damper actuated by thermostat within the jacket envelope is built into each air duct outside the building. The damper, normally closed, opens only when the exhaust pipe becomes overheated. This starts the blower immediately and delivers a cooling stream of air around the exhaust pipe, bypassing the heat to outer atmosphere. In the event that objectionable odors contaminate the indoor air, from any cause whatever, operation of all three blowers simultaneously with room ventilation openings and relief dampers open wide will change building air completely in ten minutes.

The first contract called for Unit No. 1 only, this unit to be installed and tested before any further action was taken. Unit No. 1, under test, maintained a temperature of 77 deg. in the engine room with room vents open 6 in. on both north and south sides to prevent overheating. Outdoor temperature was 50 deg. and heat transfer for warming the building was at a rate of 138,000 B.t.u. per hr. with engine load at 218 kw. and exhaust-gas temperature 320 deg. leaving engine cylinders. Results, shown in the table, paralleled the theoretical calculations so closely that the remaining units were immediately installed.

Test of Unit No. 1, Nov. 30, 1932

Time	Outside Temp.	Engine Rm. Temp.	Basement Temp.	Outlet No. 1	Outlet No. 2	Exh. Gas Temp.	Engine Kw.	Blower R.P.M.
2:30	52	76	71	118	116	320	240	560
3:00	51	76	71	116	114	315	200	561
3:30	51	77	70	116	114	310	200	560
4:00	49	78	70	114	114	315	200	560
4:30	47	78	70	115	113	340	250	560
Average, 50		77	70.4	115		320	218	560

Warm Air Delivery 3,000 c.f.m. Heat recovery, 138,000 B.t.u. per hr. Barometer 29.99 in. Ventilators open 6 in., N & S sides.

When test results were projected over the average annual seasonal temperature range it was concluded that the major part of the season, one unit would furnish sufficient heat. With two units in service, engine-room temperatures would be well above the danger point at any time during the season, and operation of all three units would hold engine-room temperature to 59 deg. in severest weather.

These conclusions were borne out during the heating season just closed. The weather held approximately the usual averages, but did undergo some sudden, extreme changes which would tax any heating plant. One extended period of cold weather included high winds and a temperature "low" of 19 deg. below zero for several hours. During this period, engine-room temperatures were maintained at comfortable levels in accordance with calculations.

Comparison of the estimated cost set-up for the independent warm-air system and a like set-up based upon the record of the waste-heat recovery system actually installed indicates that the considerable increase in initial investment for the latter is more than balanced by the savings due to utilization of heat otherwise wasted. Annual costs for the former, $581, against similar items for the latter, $274, represent an amortization of cost within 6½ yr., based upon the electrical load carried by the plant during this first heating season, during which average load was 282 kw., with a high of 311 and a low of 254.

As heating needs of the building have been satisfied and future load is expected to increase, it seems that study of future utilization of waste heat should take another direction. Already an additional use has been found, with good prospects of others which will eventually utilize all available waste heat. Jacket water heat is also being utilized, since this water is piped for the usual lavatory uses.

Building plans and specifications were drawn by A. F. Moratz, architect, Bloomington, Ill. Power generating equipment was furnished and installed by Fairbanks, Morse & Co., Chicago, Ill.; heat-recovery equipment by P. H. MaGirl Foundry & Furnace Works, Bloomington, Ill. All work under direction of C. C. Williams, superintendent of the City Water & Light Department.

Later articles will continue the series, begun last month, to which some 200 sources have contributed data. How to figure a specific installation is shown on pages 381 and 382 of this number

Neon lights, modern lighting, bathe the 176-ft. tower of the Hall of Science in mysterious light. In the foreground is a canopy and one of the unusual architectural elements, both similarly lighted

Int. News

Leaving Arcturus 40 years ago, at the time of the previous Chicago World's Fair, a light beam traveled the intervening time and distance to provide the power impulse that lit the lights of the Century of Progress Exposition

AND NOW POWER FROM THE STARS

LUBRICATION OF SMALL ST

● The small steam turbines frequently used to drive D. C. Exciter generators in central stations, rotary pumps, fans or miscellaneous machines, often present special difficulties in lubrication not found in the larger installations where provision for the most favorable operating conditions can be and usually is made. Turbines other than those connected to central station generators are usually of comparatively small size. These conditions lead to the following difficulties.

Oil temperatures are frequently high, in some instances being close to 300°F. These high temperatures are caused principally by the design of the small turbine, the bearings and oil reservoir being either placed in close proximity to the steam chest or built integral with the turbine case. Furthermore, heat radiation is minimized by the small quantity of oil (such as one gallon) used per bearing and by the frequent absence of special provision for cooling. Such turbines also are often placed in locations where the air temperatures are very high, as, for instance, over boilers to drive blower fans.

These factors which cause high lubricating oil temperatures necessitate the use of comparatively heavy bodied oils to maintain a satisfactory oil film in the bearings. Usually, under the more extreme conditions heavy mineral cylinder oils must be used for this reason.

The prevalent high temperatures introduce further difficulties because deterioration and sludging of the oil is greatly accelerated. This is especially important in the case of the smaller turbines since it usually is not feasible to provide oil filtering equipment.

Sludge accumulates in the comparatively small oil reservoirs and may cause serious bearing failures by clogging oil grooves, etc. Thus it is important to select oils which are highly resistant to sludging under the conditions encountered in this service. Turbine oils that will not sludge in years of service under the lower temperature conditions chacteristic of large central station turbines, may deteriorate very rapidly under the higher temperatures found in some auxiliary equipment. Entirely different types of oils are required and discrimination should be used in their application under high temperature conditions.

Sometimes steam turbines of this class are connected to machinery through separate reduction gears. While reduction gears require comparatively viscous oils for their lubrication, the gear oil may not be satisfactory for lubrication of the turbine bearings and adequate provision must be made to see that an interchange of mixture of the oils does not occur.

More commonly, reduction gears are built integral with the turbine and are supplied with the same oil as the latter by a common oil pump. In such units means for oil cooling is almost always provided, so that oil temperatures are lower, being similar to those found in central station units. For the reduction gears, moderately heavy oils are required, and the bearings, which otherwise would require light oils, are adapted to the heavier oils, by slightly increasing the clearances. Care must be taken to use oils no heavier than required for the gears.

In all cases like that above where bearing temperatures are 170°F. or below, the considerations governing lubrication of central station turbines apply, and reference should be made to the monograph on Steam Turbine Lubrication for further suggestions.

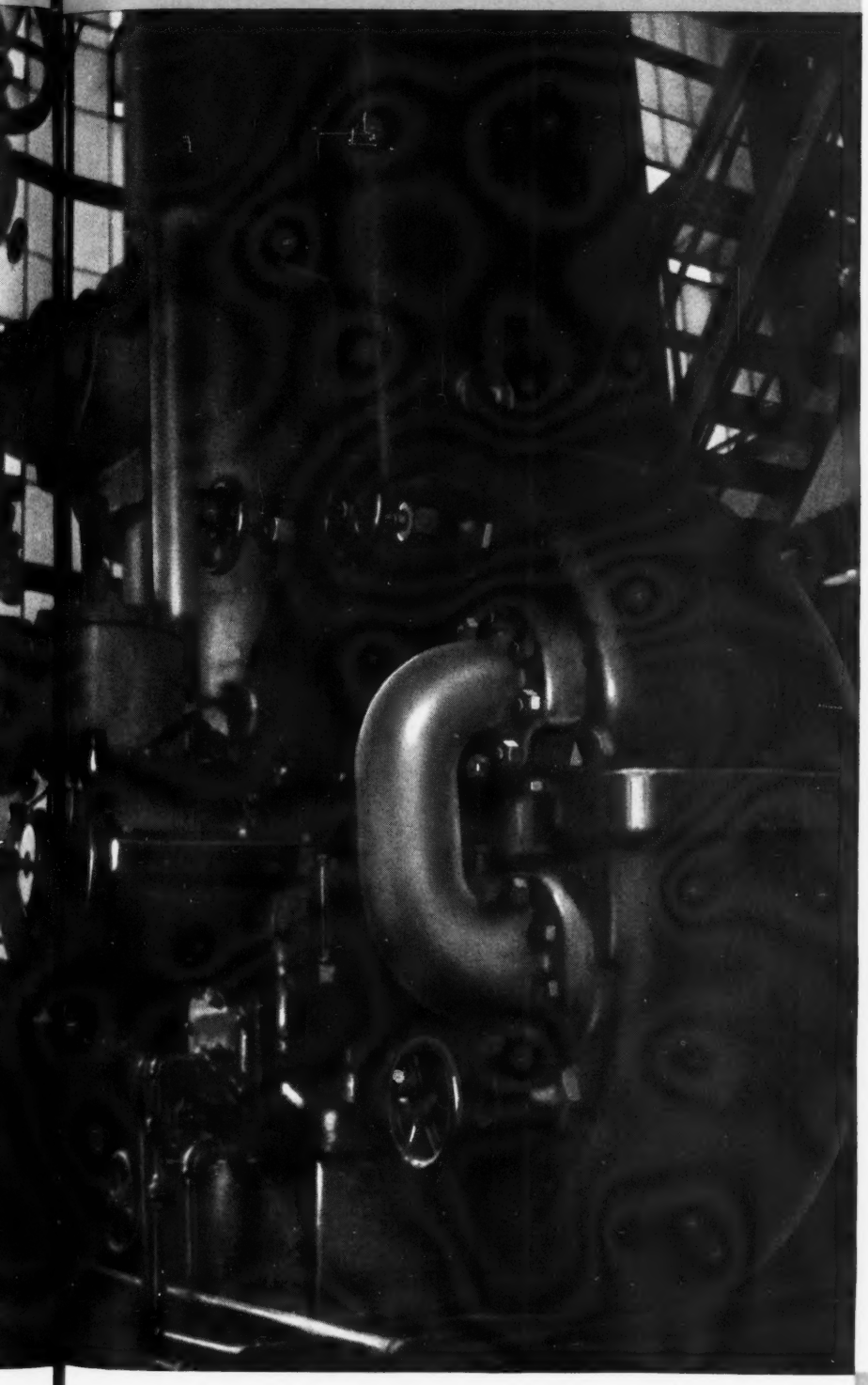
Small steam turbines frequently are used to operate blowers, and rotary pumps, to which they are direct connected. Usually it is necessary to place such equipment in very dusty surroundings, as in the boiler room. It is difficult to keep the dust and dirt from finding its way into the oil system, with consequent detriment to lubrication. Adequate precautions must be taken to prevent this since when mixed with the comparatively large amounts of oil sludge which may be found in such cases, serious results may follow. For this reason frequent changes of oil and cleaning of the oil reservoir should be enforced. Because of the small oil capacity, the expense will be nomial and amply justified by the greater assurance of trouble-free operation.

Often it is necessary to place auxiliary turbines in locations where provision for cooling water is inconvenient. In many instances, however, the extra cost of lines, etc., for cooling water will make possible greatly increased oil life because of the resulting lower temperature, which will amply repay the cost of cooling facilities.

Because such turbines are in an out of the way location, special supervision may be necessary to see that they are adequately serviced and inspected by the operating personnel.

Small steam turbines sometimes are equipped with ball or roller bearings. In such cases, they should be serviced in accordance with the principles outlined in the Monograph on Electric Motor Lubrication where anti-friction bearings are discussed. More frequently, however, ring-oiled journal bearings are employed. Periodic inspection should be made to insure that the ring is properly rotating on the shaft, otherwise the supply of oil will fail and the bearing damaged. In the unusual case where the turbine is in an unheated room, the oil should be preheated before starting in cold weather to insure that adequate lubrication is obtained from the start. This may also be necessary at room temperatures when mineral cylinder oils are used since such products are very viscous when cold and may prevent rotation of the ring.

STEAM TURBINES



SMALL TURBINES USUALLY REQUIRE SPECIAL LUBRICANTS

The higher operating temperatures of small size turbines, their comparatively small oil reservoirs and openings produce lubricating problems seldom encountered in large turbines. As a result, special types of lubricating oils generally are necessary.

To meet the particular operating conditions encountered with small turbines, the Standard Oil Company (Indiana) manufactures four turbine oils.

Stanolind Turbine Oil Medium is recommended whenever a medium bodied oil is found to be best suited to operating conditions. It will withstand the higher operating temperatures of small turbines.

Stanolind Turbine Oil Heavy is especially qualified to give unusual lubrication in turbines equipped with reducing gears. It has exceptional lubricating properties and, for an oil of this viscosity, possesses a rapid rate of separation from water.

Stanolind Turbine Oil Extra Heavy has the unusual qualities necessary for lubrication of ring oiled bearings on small turbines where, because of proximity of bearings to steam chest, they operate at high temperatures.

Superla Mineral Cylinder Oil usually is the best recommendation for the difficult job of lubricating ring oiled bearings where water cooling is not employed and as a result, temperatures are high.

Sometimes it is difficult to decide which lubricant is best suited to your particular requirements. A wise course of action is to request a Standard Oil Lubrication Engineer to assist you.

STANDARD OIL COMPANY
(Indiana) 1319

910 South Michigan Avenue Chicago, Illinois

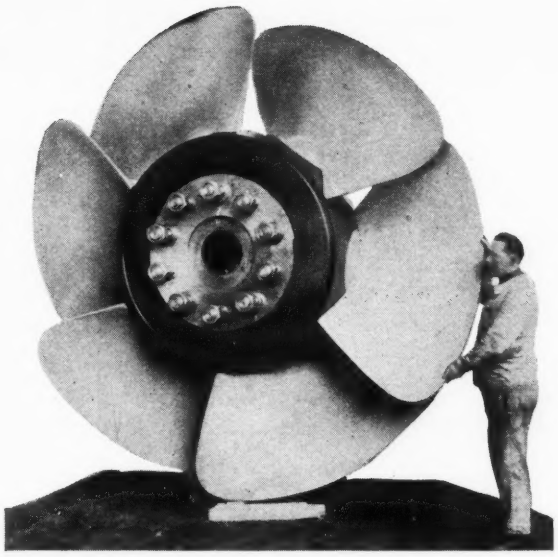
© POWER

PROPERTIES of AIR-WATER VAPOR MIXTURES

Temp., Deg. F.	Relative Humidity—Per Cent — 10 Lb. Moisture: Per 100 Lb. Dry Air	10 Lb. Moisture: Per 1,000 Cu. Ft.	20 Lb. Moisture: Per 100 Lb. Dry Air	20 Lb. Moisture: Per 1,000 Cu. Ft.	30 Lb. Moisture: Per 100 Lb. Dry. Air.	30 Lb. Moisture: Per 1,000 Cu. Ft.	40 Lb. Moisture: Per 100 Lb. Dry Air	40 Lb. Moisture: Per 1,000 Cu. Ft.	50 Lb. Moisture: Per 100 Lb. Dry Air	50 Lb. Moisture: Per 1,000 Cu. Ft.	60 Lb. Moisture: Per 100 Lb. Dry Air	60 Lb. Moisture: Per 1,000 Cu. Ft.	70 Lb. Moisture: Per 100 Lb. Dry Air	70 Lb. Moisture: Per 1,000 Cu. Ft.	80 Lb. Moisture: Per 100 Lb. Dry Air	80 Lb. Moisture: Per 1,000 Cu. Ft.	90 Lb. Moisture: Per 100 Lb. Dry Air	90 Lb. Moisture: Per 1,000 Cu. Ft.	100 Lb. Moisture: Per 100 Lb. Dry Air	100 Lb. Moisture: Per 1,000 Cu. Ft.
20	0.026	0.018	0.034	0.036	0.060	0.054	0.085	0.072	0.104	0.090	0.123	0.108	0.143	0.126	0.164	0.144	0.186	0.162	0.2142	0.18
25	0.027	0.022	0.043	0.044	0.074	0.066	0.100	0.088	0.129	0.110	0.157	0.132	0.187	0.154	0.214	0.176	0.240	0.198	0.2723	0.22
30	0.029	0.028	0.057	0.056	0.093	0.084	0.129	0.112	0.164	0.140	0.207	0.168	0.243	0.196	0.271	0.224	0.307	0.252	0.3444	0.28
35	0.030	0.034	0.073	0.068	0.121	0.102	0.164	0.136	0.208	0.170	0.254	0.204	0.300	0.238	0.336	0.272	0.379	0.306	0.4268	0.34
40	0.039	0.041	0.093	0.082	0.149	0.123	0.207	0.164	0.257	0.205	0.307	0.246	0.360	0.287	0.414	0.328	0.471	0.369	0.5202	0.41
45	0.049	0.050	0.114	0.100	0.186	0.150	0.250	0.200	0.314	0.250	0.372	0.300	0.429	0.350	0.496	0.400	0.571	0.450	0.6319	0.49
50	0.058	0.058	0.143	0.116	0.221	0.174	0.300	0.232	0.379	0.290	0.457	0.348	0.528	0.406	0.600	0.464	0.686	0.522	0.7623	0.58
55	0.071	0.070	0.178	0.140	0.264	0.210	0.357	0.280	0.450	0.350	0.543	0.420	0.643	0.490	0.728	0.560	0.829	0.630	0.9205	0.70
60	0.086	0.082	0.214	0.164	0.322	0.246	0.429	0.328	0.543	0.410	0.650	0.492	0.764	0.574	0.878	0.656	0.986	0.738	1.105	0.82
65	0.100	0.100	0.250	0.200	0.386	0.300	0.514	0.400	0.650	0.500	0.772	0.600	0.914	0.700	1.043	0.800	1.185	0.900	1.323	0.98
70	0.129	0.115	0.293	0.230	0.457	0.345	0.614	0.460	0.772	0.575	0.928	0.690	1.086	0.805	1.243	0.920	1.400	1.035	1.578	1.15
75	0.157	0.135	0.357	0.270	0.543	0.405	0.728	0.540	0.928	0.675	1.100	0.810	1.286	0.945	1.472	1.080	1.671	1.215	1.877	1.35
80	0.193	0.156	0.414	0.312	0.643	0.468	0.857	0.624	1.086	0.780	1.300	0.936	1.528	1.094	1.756	1.248	1.985	1.404	2.226	1.56
85	0.236	0.185	0.500	0.370	0.757	0.550	1.014	0.745	1.272	0.925	1.528	1.110	1.814	1.295	2.070	1.480	2.328	1.665	2.634	1.83
90	0.286	0.213	0.586	0.426	0.886	0.639	1.200	0.852	1.500	1.065	1.814	1.278	2.127	1.491	2.428	1.704	2.757	1.917	3.109	2.13
95	0.343	0.245	0.700	0.490	1.043	0.735	1.414	0.980	1.756	1.250	2.127	1.500	2.500	1.750	2.871	2.000	3.242	2.205	3.662	2.469
100	0.400	0.285	0.814	0.570	1.228	0.855	1.656	1.140	2.056	1.425	2.500	1.710	2.928	1.995	3.371	2.280	3.858	2.565	4.305	2.85
110	0.529	0.376	1.100	0.752	1.656	1.128	2.228	1.504	2.814	1.880	3.358	2.256	4.000	2.632	4.643	3.008	5.295	3.385	5.93	3.76

	DRY-BULB TEMPERATURE, DEG. F. — 20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	110	120	130	140	150
Volume, Cu. Ft. 1 Lb. Dry Air	12.09	.....	12.34	12.47	12.59	12.72	12.84	12.97	13.10	13.22	13.35	13.48	13.60	13.73	13.86	13.98	14.11	14.36	14.62	15.00	15.13	15.39
Volume 1 Lb. Dry Air + Vapor To Saturate	12.13	.....	12.41	12.55	12.70	12.85	13.00	13.16	13.33	13.50	13.69	13.88	14.09	14.31	14.55	14.80	15.08	15.73	16.52	18.13	18.84	20.60
Heat Content, B.t.u. per Lb., Dry Air above 32° F.	....	.....	.....	.72	1.93	3.14	4.35	5.56	6.76	7.97	9.18	10.39	11.60	12.81	14.02	15.23	16.44	19.36	21.78	24.20	26.63	29.05
Heat Content*, B.t.u. per Lb. Sat. Air above 32° F.	....	.....	.....	5.30	7.54	9.96	12.61	15.53	18.76	22.27	26.38	30.90	35.96	39.16	48.22	55.57	63.97	85.11	112.03	148.70	197.33	267.75

*Total heat of vapor from Keenan's Steam Tables.



Kaplan runner to operate under 76-ft. head

10,700-HP. KAPLAN TURBINES DESIGNED FOR 76-FT. HEAD

IN THE Wettinger plant, City of Zurich, Switzerland, the Kaplan turbines are outstanding for the high head (76 ft.) under which they will operate. This plant is on the Limmat River about 12 miles from Zurich. There are being installed three 10,700-hp. Kaplan turbines to operate at a speed of 214 r.p.m., coupled to 10,000-kva. generators. Because of the variations in tailwater level the head will vary from 76 ft. when flow in the river is low to about 70 ft. at high flow. The headwater level will remain practically constant, so that nearly all the head change will be due to differences in tailwater level. Each turbine discharges into a draft tube that leads into a tunnel 1,300 ft. long, which was another of the unusual conditions that had to be considered in the design of the turbines.

Francis Type Also Considered

During the preliminary studies to determine the type of turbine best suited to the conditions, the francis type was also considered. Because of the variable flow in the river, 1,483 to 8,475 sec.-ft., the variation in tailwater level and the peculiar draft-tube conditions due to the long discharge tunnels, test on models showed the Kaplan turbine to be superior to the francis type even if the former were considerably higher in first cost. To compensate for the higher cost, the better efficiency of the Kaplan turbines will result in about 5,000,000 kw.-hr. more annual output than would be obtained with francis-type turbines. Because of the higher speed of the units selected, there is also a considerable saving in the cost of the generators.

The guaranteed ratings of the turbines is 9,660 hp. at 70-ft. head and 10,700 hp. at 76-ft. head, the discharge being 1,412 sec.-ft. at the different full-load ratings. Because of the long discharge on the draft tubes, the problem of regulating the speed of the units has been intensified. The guaranteed speed regulation is, however, a maximum rise of 4 per cent when a 2,675-hp. load is suddenly dropped, 7 per cent rise for a load rejection of 5,535-hp. and 22 per cent for sudden loss of 10,700-hp. load.

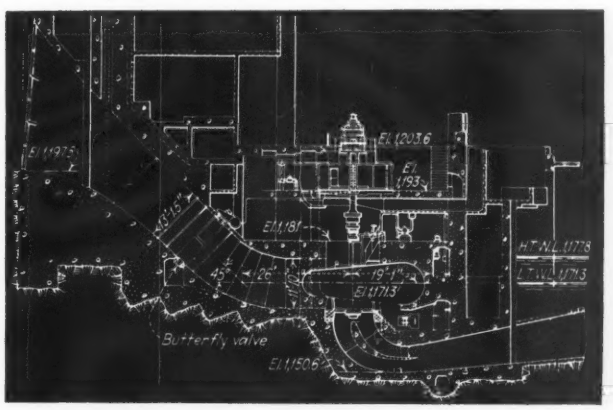
The diagram shows a cross-section through one of the units. The spiral casing is of welded plate-steel construction and terminates at an oil-pressure operated butterfly valve in the concrete structure. As used in several other European installations, the draft tube has a curved baffle in its elbow.

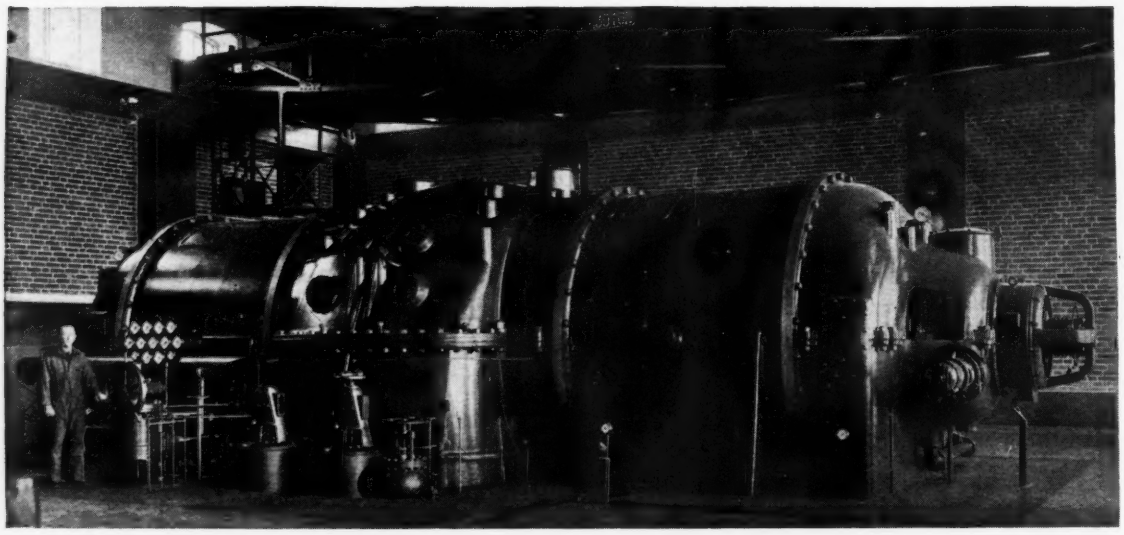
The spiral casings, which have a maximum diameter of 34 ft. 5 in., are made of steel plates fabricated to form single segments of the casing and welded together. Because of transportation difficulties each casing was constructed in four quadrants at the shops, then shipped to the plant where they were welded together and to the speed ring.

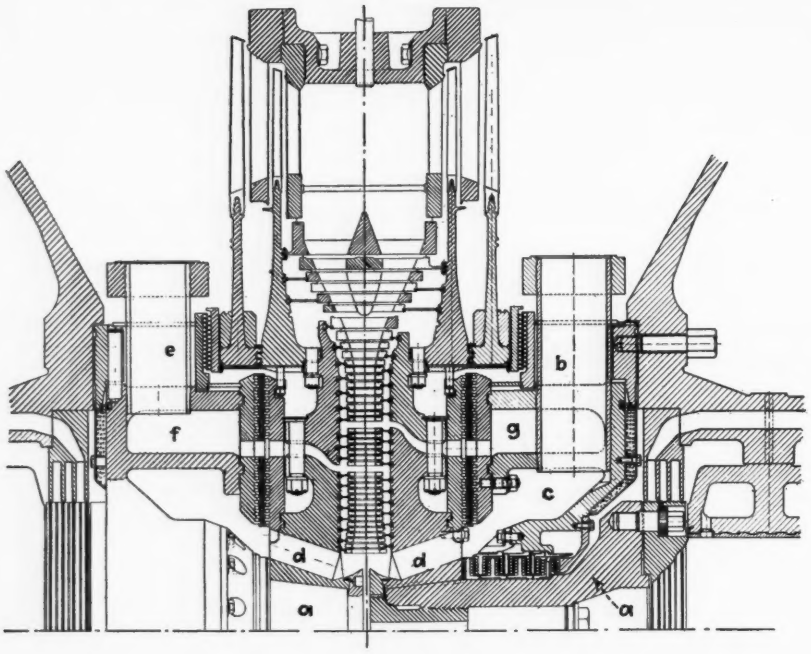
At low-water, the tailwater level will be at the elevation of the centerline of the turbine and at high water the tailwater level will be over 6 ft. above the turbine centerline. Provisions have been made to depress the water in the turbines casing below the runner with compressed air, if it is ever desirable to operate any of the generators as synchronous condensers for power-factor correction. One of the runners is shown in the photograph. Notwithstanding its large output, because of the comparatively high head, the runner has a relatively small diameter.

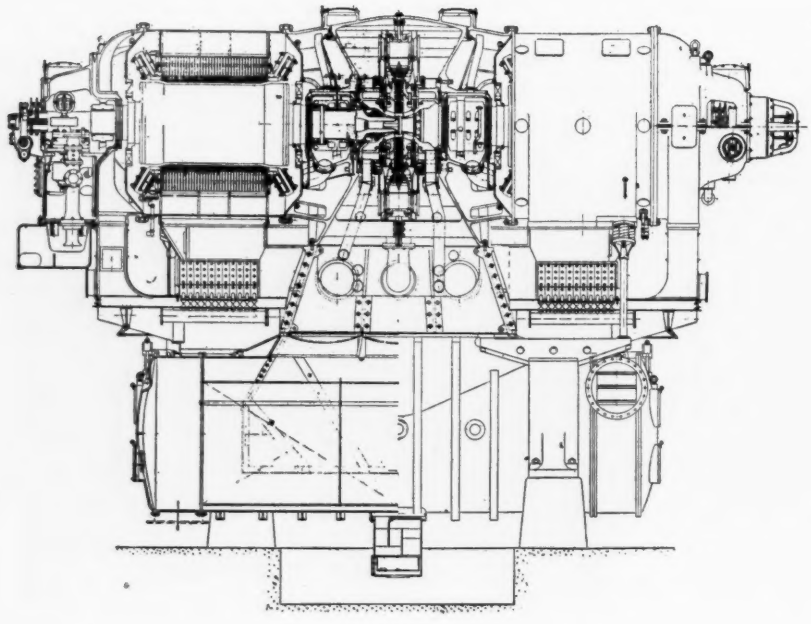
The information in this article was supplied by the Escher Wyss Engineering Works, Ltd., manufacturers of the turbines.

Cross-section through one of the three 10,700-hp. units in the Wettinger plant









VASTERAS TURBINE

LARGEST DOUBLE-ROTATION UNIT

By A. G. CHRISTIE
Johns Hopkins University

Tests on this 50,000-kw. radial-flow turbine generator gave an over-all efficiency ratio of 82 per cent. Here are described details of this unit, obtained by the author during a recent visit to Sweden.

Fig. 1 (Top)—S.T.A.L. Ljungstrom turbine of 50,000 kw. at Vasteras, Sweden

Fig. 2 (Center)—Cross-section of upper half of turbine

Fig. 3 (Left)—The turbine is supported on the condenser, and cast iron yokes carry the generators

THE largest double-rotation turbine so far built has been placed in operation at Vasteras, Sweden, and thoroughly tested. It has a capacity of 50,000 kw. and is designed for steam at a throttle pressure of 285 lb. per sq.in. abs. and 840 deg. F. temperature. Built on the reaction principle, steam flow is radial for the greater part of its expansion, but two stages of double-flow axial low-pressure blading are used to provide the large exhaust areas necessary to secure a low leaving loss.

The relative velocity of the two sets of blades in the radial flow section is twice that obtainable in an axial flow unit where one set of blades is stationary. For a given radius, number of revolutions, and given ratio of blade speed to steam speed, a stage in the Ljungstrom turbine can utilize four times as much energy as a similar stage in the axial-flow turbine. Or conversely smaller diameters of stages may be used in the double-rotation turbine for the same heat drop as in the axial-flow. Both these ideas are used here, with the result that the first stages are of small diameter while the total number of stages is small compared to single-flow reaction designs. At the same time, high efficiency is secured since relatively long blades with full admission and low leakage losses must be used in the first rows.

Fig. 2 shows a half section of the 50,000-kw., 1,500-r.p.m. turbine. Steam enters through pipe *b* and through a corresponding one not shown on the opposite side and passes through ports *d-d* into the revolving elements at the first blade row. Steam flows through 41 rows of radial blades and then is double flow through two axial stages. The total exhaust pipe area from the turbine is about 215 sq.ft., or about 4.5 sq.ft. per 1,000 kw. of output. Employment of radial-flow stages leads to a compact design so that even with the two generators, the total length compares favorably with the axial-flow type.

The complete unit, as shown in Fig. 3, is about 48 ft. long over-all, 28 ft. wide over-all, and 35 ft. from condensate pit floor to highest point of the turbine which includes the condensing equipment. It is installed in an old plant with fixed basement levels. Hence, twin condensers had to be employed to fit available head room. Under normal conditions, head room from basement floor to the top of the turbine would have been 41 ft.

This type of turbine is always mounted directly on the exhaust nozzle of the condenser, and both turbine and generators are carried by the condenser frame as shown in Fig. 3. No foundations are necessary except those under the condenser. In common with European practice, the condenser shell is made of welded steel construction connected to heavy cast-iron yokes at both ends which carry the weight of the superimposed generators. In the Vasteras plant, an operating floor was provided at the turbine level as shown in Fig. 1. The two generators, run at the same speed, are tied together electrically and function as a single unit.

Only the parts near the center of the unit are exposed to high temperatures and pressures. Since these parts are of small size, it is possible to employ as high temperatures and pressures as are available. A 3,000-kw. turbine of standard design has been successfully tested with 1,000 deg. steam temperature. All parts of the elements carrying the blades are equally affected by centrifugal forces and temperature changes, so that the clearances at the tightening edges of the blade rings can be made materially smaller than the clearances in axial-flow turbines, which leads to increased economy.

Blades in the radial-flow section are milled from the solid with shanks on each end as shown in Fig. 4. When these blade shanks are placed in the groove of a blade ring which is turned sufficiently open to permit the blades to drop into place, they are automatically spaced at the proper angle. Then the groove is closed by rolling the metal of the blade ring into one of the indentations on the blade shank. Another similar blade ring is placed over the other end of the blade and the groove closed in the same manner. Fig. 5 shows the two rotating elements held in their assembling gear and about to be put together for placing in the turbine.

The few blade rings and the short passage of the steam from inlet to exhaust results in small friction losses. Windage losses are almost negligible. As a consequence, the no-load steam of the turbine is smaller than in other types. Hence, the unit can be run economically as a synchronous generator for power factor correction. The Vasteras plant runs in parallel with hydro stations, and the unit may be motored at times.

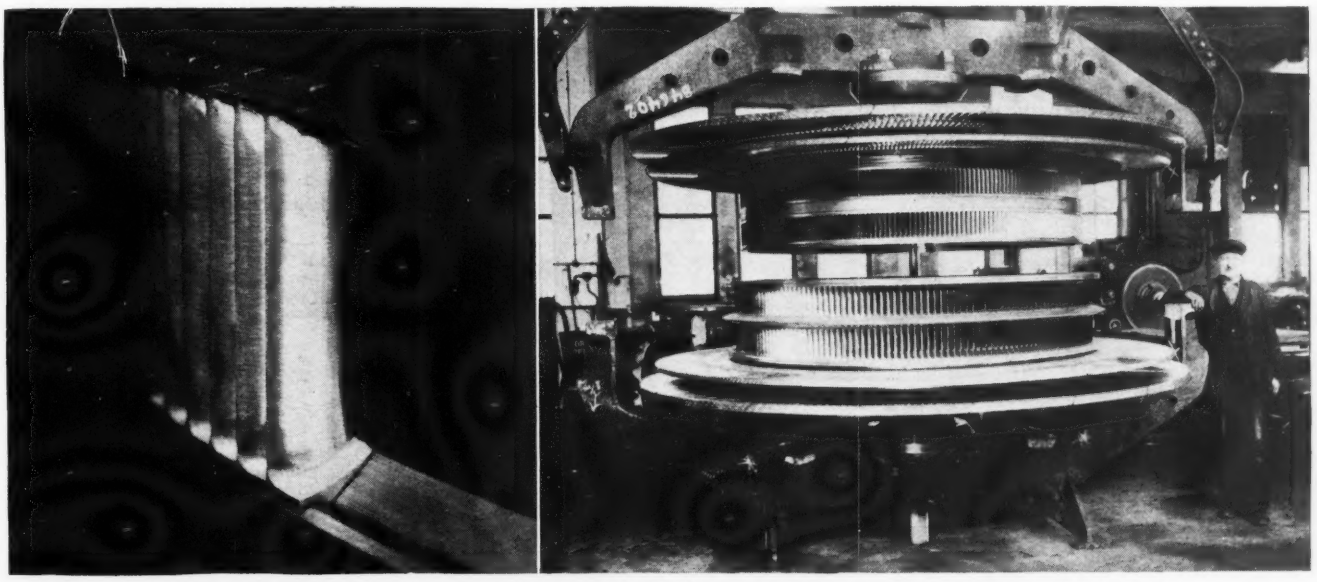


Fig. 4 (Left)—After the blades are inserted, the metal of the supporting ring is rolled over to hold them in place. Fig. 5—Two rotating elements of 50,000-kw. turbine and assembly gear

TABLE I

Number of Test	High Vacuum 1	High Vacuum 2	Low Vacuum 3	Low Vacuum 4
Duration of test, min	20	20	20	20
Pres. before inlet (1), lb. per sq.in.abs.	233.6	273.8	230.8	257.4
Pres. after gov. valve, lb. per sq.in.abs.	210.3	111.6	214.6	118.9
Pres. in exhaust pipe, in. hg. abs.	0.88	0.634	1.95	1.53
Temp. before inlet valve, deg. F.	800.6	798.8	799	802
Temp. of condensate (2), deg. F.	71.6	66.0	88.5	84.9
Steam quantity to turbine, lb. per hr.	262,126	135,891	266,095	145,724
Generator output, kw.-hr.	31,163	14,996	29,905	14,807
Steam consumption, lb. per kw.-hr.	8.41	9.06	8.9	9.84
Over-all efficiency ratio, per cent	82.4	73.0	85.3	74.0

(1) Measured about 3 ft. before inlet valve.
(2) Measured after mixing of turbine condensate with condensate entering water cooler from leakage condenser and ejectors.

No heat insulation is required on the turbine, as it is contained wholly inside the exhaust casing. Provision has been made for two bleeding passages at points *f* and *g*, Fig. 2, to extract steam for feed-water heating.

Conical bolts are used to hold the parts together, as shown in Fig. 2. This construction has made it possible to build turbines in the larger sizes.

The double-flow, low-pressure disks can be designed for high tip speeds and large exhaust areas. In Fig 2, the last disk is reinforced at the hub by two shrink rings.

The shaft packing is subject to full steam pressure and is of the pine-tree type with suitable leak-off connections. The dummy labyrinth balance packings are of the original Ljungstrom design.

Speed regulation is secured by throttling the steam supply, the governor being driven from one of the generator shafts. The electrical connection of the two generators maintains both at the same speed.

Since the parts of the turbine are of relatively small section and can be easily reached by steam, the unit is comparatively insensitive to temperature changes and can be started without preliminary heating.

Several series of tests were made on the unit by Profs. Alm and Lindmark of the Engineering College at Stockholm. The first tests were made with relatively low-temperature steam from the old boilers in the plant and with only one bleeder heater in operation. Results corrected to guarantee conditions showed that the heat consumption was less than guaranteed. Two sets of tests were then made without extraction for feed heating, one set at high vacuum and the other at a lower vacuum. The principal results are shown in Table 1. Condensate was measured to determine steam consumption. The lower vacuum in the last two tests was secured by admitting air to the condenser. Owing to system load conditions, tests could only be run up to about 30,000 kw. capacity.

The efficiency ratios in the tests with the lower vacuum are higher than in the tests with high vacuum because of higher leaving losses in the latter tests. The builders have determined the generator and mechanical losses of this unit and find that the internal efficiency of the turbine alone in Test No. 3 is 89.2 per cent when computed on Keenan's Mollier diagram. This figure is one of the best that has been secured on any steam turbine.

The basic patents on the Ljungstrom turbine in the United States recently expired, and some of our manufacturers may now interest themselves in the construction of this type that has proved satisfactory in Europe.

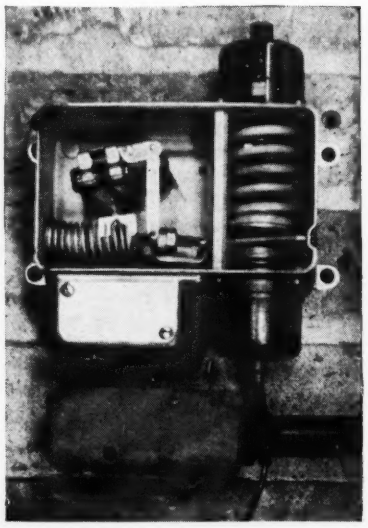
Kinks from Milwaukee

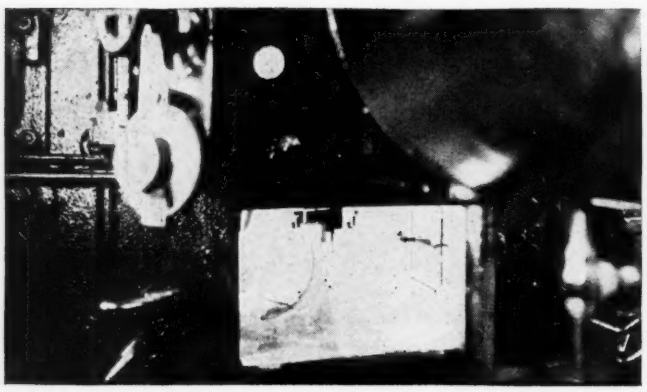
KINKS here shown are in use in the plant of the Milwaukee (Wis.) Chair Company, where they were photographed by a member of the *Power* Staff, through the courtesy of L. A. Corwin, chief engineer.

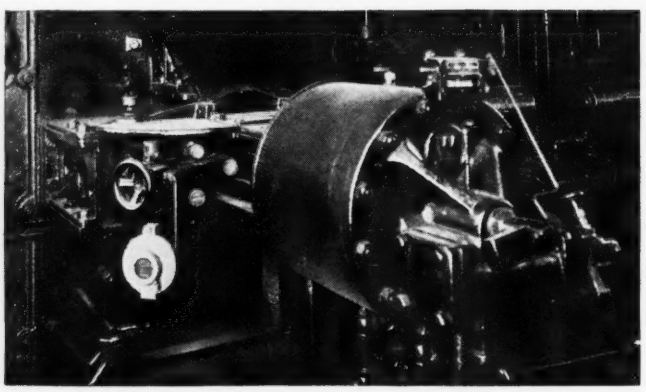
1. Automatic draft fan control (right) is provided by a simple device on the boiler-room wall. Boiler pressure acting on a spring-weighted metal bellows trips a mercury switch to start or stop the fan.

2. Ash-pit lights (lower left), wired to outside switches where they can be conveniently controlled, simplify ash-pit inspection.

3. Stokers chart their own operation (below). In addition to the usual stroke counter, each hydraulic stoker is equipped with a "hub cap" recorder of the type used to record the actual periods of operation of a motor truck or other commercial car. Key locks recording mechanism to avoid tampering.







Inside, an extensive automatic CO_2 system gives major protection; outside, water protects transformers from oil fires

CO_2 & H_2O PROTECT Safe-Harbor Plant from Fire

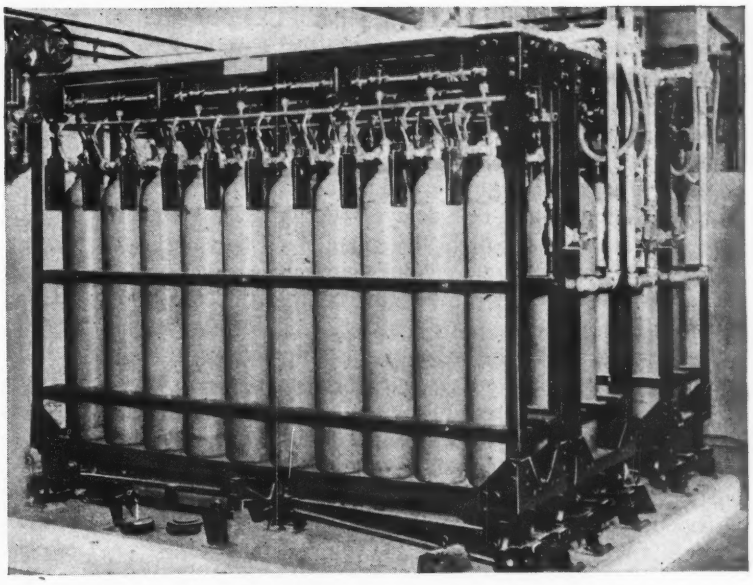


Fig. 1—Fifty containers of CO_2 gas give plant fire protection

By J. B. CUTLER
Mechanical Engineer,
Safe Harbor Water Power Corporation

EXPERIENCE shows that there are grave possibilities of power-plant equipment being seriously damaged by fire. With this in mind, the engineers, when designing and building Safe Harbor hydro-electric plant, provided fire-fighting facilities that they believe will handle any emergency. For compartments within the station containing such equipment as oil tanks, switches or electrical machinery, which present a rather serious hazard, CO_2 gas has been selected as most satisfactory means for extinguishing fires. Water is used for other spaces inside the power house, such as offices, large machinery rooms, and for all outside locations. Portable CO_2 extinguishers are placed in convenient locations throughout the plant.

A central battery of fifty 50-lb. CO_2 gas containers is connected to a central piping system, and may be discharged automatically, or by hand, through branch lines to the compartment in which fire has occurred. The battery of gas containers as now installed is shown in Fig. 1.

This gas has several advantages in closed areas over liquid-type extinguishers. Operation of the CO_2 system requires no skill. In view of the rapid discharge of gas and its ability to spread in three dimensions, penetrating cracks and crevices, the fire is extinguished quickly. CO_2 gas is a non-conductor of electricity, is non-corrosive and non-poisonous, and leaves no dirt to be cleaned up after its application. This gas is particularly advantageous in windings of electrical machinery, as it should be possible to place equipment in service more quickly after a fire than when other fire-extinguishing methods have been used.

Figs. 2 to 4 indicate how the central CO_2 system is installed to protect the totally enclosed main unit generators, the oil circuit breaker compartments and the room containing the oil purifying machinery. Only two of the six oil-circuit breaker compartments are shown, but the others are protected similarly. The oil-storage-tank compartments, the fuel-oil storage and fuel-oil pump room are protected similarly to the oil purification room.

Thermostats in each compartment will function to open the direction valves in the branch line leading to that compartment and will also open the main cutter valves at each 50-lb. container to be released. Each valve is opened mechanically through action of a falling weight, which is released electrically when a solenoid is energized. Direction valves in branch lines to each compartment are located in an accessible hallway or stairway just outside the compartment, as in Figs. 3 and 4, and may be operated manually if desired. Manual operation of these valves will automatically open the main cutter valves, as when the thermostats function.

CO_2 gas is discharged into each compartment through a series of small nozzles spaced approximately 10 ft. apart in pipe headers along the walls. Since CO_2 gas is heavier than air, these headers are approximately two-thirds of the vertical distance between floor and ceiling above the floor.

To provide for compartments reasonably tight against gas leakage, pressure switches are installed in the branch lines to close doors or louvers automatically in each compartment by releasing weights when pressure builds up in the gas-supply lines. Where a compartment is ventilated by a fan, provision is made to shut the fan down automatically in an emergency by a pressure-operated mercoid switch.

Fifty gas containers are located at the center of the station, Fig. 2, and gas is carried to the compartments

through one 2-in. and two 1¼-in. pipes. Gas pressure in the containers is 750 lb. per sq.in., and extra-heavy galvanized pipe is required for the distribution system.

In all compartments except generator enclosures, the required quantity of CO_2 gas is discharged in one operation in approximately one minute. For the generator enclosures it was thought best to provide one initial rapid discharge of gas, and one delayed discharge to compensate for leakage through the plate-steel housing and louvers. This leakage may be appreciable due to fan action of the generator rotor before being completely shut down. The initial discharge of gas is delivered to the generator through a 2-in. pipe in approximately one minute and the delayed discharge through a ¾-in. pipe in approximately three minutes. Fig. 5 shows the general arrangement of the connections from the gas lines to one generator and inside the machine. The initial charge of gas is discharged into the generator through an open tee connection on the 2-in. line. The delayed charge is supplied through a 11/32-in. orifice nozzle on the opposite side of the generator from the tee connection for the initial charge.

In view of the different compartment volumes to be protected, different quantities of gas are required in each. Arrangement of pipe connections is such that gas may be released from one or more groups of ten containers, depending upon compartment size. The arrangement of containers, their size and compartments to which they connect are indicated in Fig. 6. It will be seen that the manually controlled bank can be discharged to any hazard.

A gas quantity is used sufficient to provide a concentration of 45 per cent, required for effective fire extinguishing. When discharged from the system, the gas expands to 450 times the compressed volume.

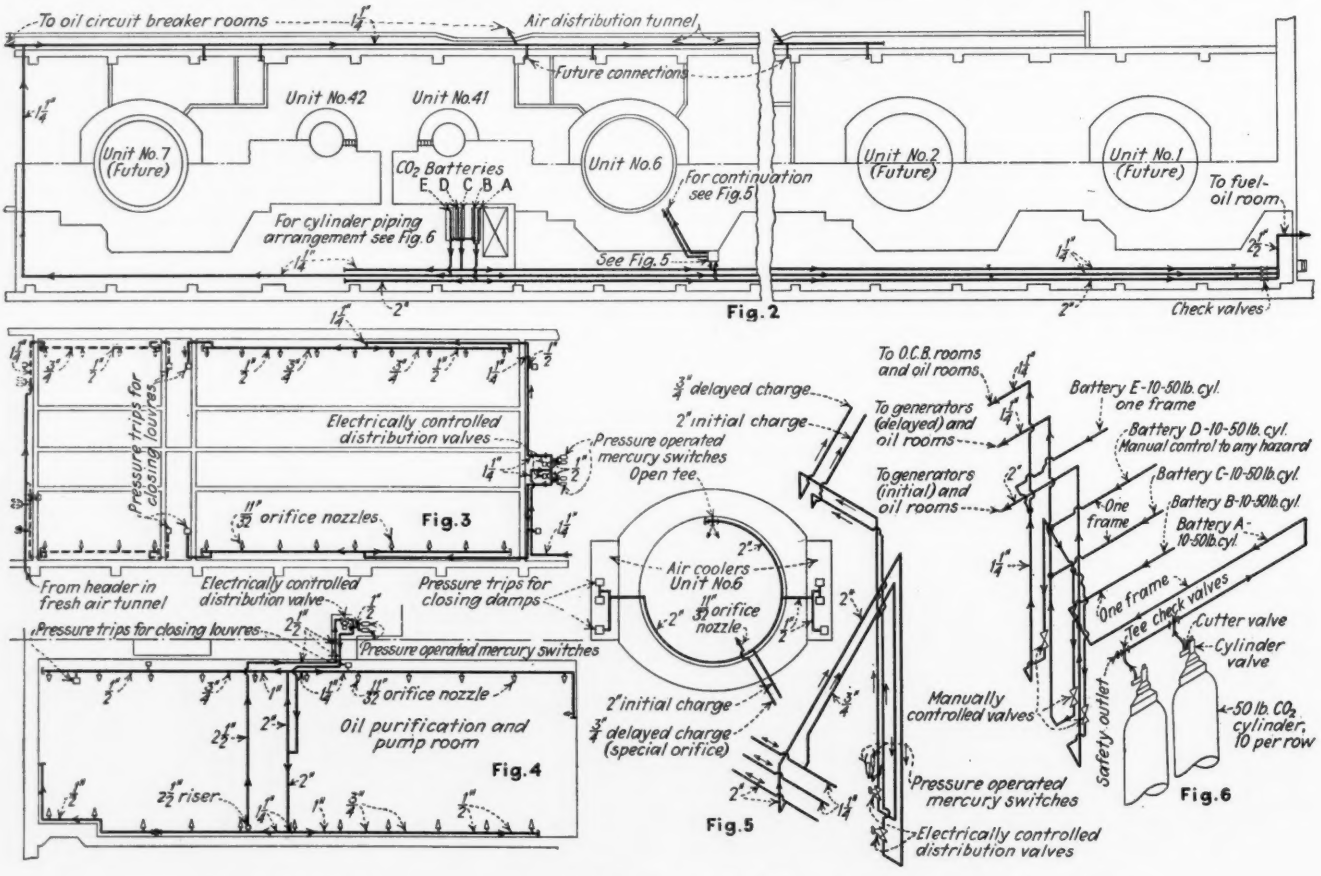
Fig. 7 is a simplified diagram of the electrical circuits for the system. When the thermostat closes, it provides a circuit through the electrical releases on the CO_2 cylinders and the distributing valves protecting the equipment. Closing the manual-control switch will perform the same functions as closing a thermostat. If a short-circuit in a generator causes the differential relay to operate, an auxiliary relay, Fig. 7, is closed to bring the CO_2 system into operation.

At the direction valves outside each compartment are a red and a green signal light, connected as in Fig. 7. Normally the green lamp is illuminated. As soon as gas pressure is applied to the system the mercury switch is tilted to light the red lamp and show that gas is being supplied. Another mercury switch, Fig. 7, is tilted when gas pressure is on the system, closes the circuit for an audible alarm to indicate that the fire extinguishing system is functioning properly.

In the building office section, one water-hose connection is provided at each floor in a hallway. One 50-ft. length of 1½-in. linen hose with ⅝-in. nozzle is permanently connected at each water outlet. In the generator room is stationed a portable reel with 100 ft. of rubber-lined, 2½-in. hose which may be connected to any of the single outlets provided near each main unit. Rubber-lined hose was selected for this area to prevent accidental spraying of electrical machinery by hose leakage.

The control room is protected by two 50-lb. CO_2 containers, mounted together on a wheel cart and immediately available for use.

For protection of transformers against fire, water was



Figs. 2 to 6—Piping arrangements for using CO_2 gas to fight fire in different parts of the plant

selected as most satisfactory. Outdoor-type transformers are located on the intake decks in open pockets. Water was selected after a series of tests conducted by the power company, on an old transformer tank. This tank, with top dimensions approximately the same as the Safe-Harbor transformers, was arranged with its top at the same elevation above the floor as the transformers. The test tank was located in an outdoor pocket of temporary corrugated-sheet steel, built to equal the concrete transformer enclosures at Safe Harbor.

For the tests, the tank was partly filled with water, with transil oil to a depth of approximately 12 in. floating

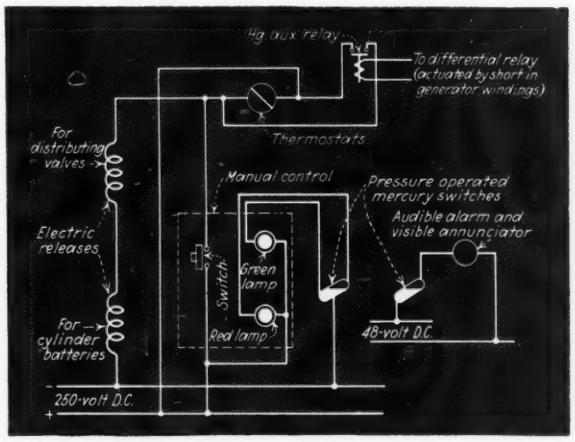


Fig. 7—Simplified diagram of the electrical circuits for the CO_2 system

on top. A steam coil was used to heat the oil before igniting. To simulate the most serious type of fire hazard, oil while burning was overflowed from the tank by admitting water to its bottom. In addition, free oil was discharged over the tank top, simulating conditions that might exist from a transformer-bushing failure. Fires of great intensity were developed and are believed to have closely duplicated actual conditions.

Tests were made using gas, a liquid similar to soda acid, and water. No liquid chemicals providing a surface binder to smother fire were tested, as the time required for cleaning the equipment after using such liquids was considered a serious objection. No liquid chemicals other than soda acid were tested, as it was found that other fluids could not be discharged in sufficient quantities to be effective on these large transformers.

It was found possible to produce liquid similar to soda acid in sufficiently large quantities, by passing a continuous stream of water through a "duo mixer." This equipment consisted of two funnel-shaped hoppers connected to an ejector, through which water passed, drawing the chemicals from the hoppers into the stream. Aluminum sulphate was fed into one hopper and sodium bicarbonate into the other. This combination of chemicals formed CO_2 gas, which was carried along with the water stream in the form of bubbles. Characteristics of such a stream are like those of a stream discharged from the usual soda-acid extinguisher.

At Safe Harbor, a 4-in. fire water supply main is installed in front of the transformer pockets, and runs the length of the intake-deck. Hose connections are furnished opposite the transformers. With two sections of hose, water may be carried from the main to the pipe header at the base of the wall on each side of the transformer. To each of these two headers are connected six vertical pipes, embedded in the wall. Each pipe is bent at the upper end to project outward from the wall and downward, directing the water streams over the top and sides of the transformer tank. Because of their shape these pipes are referred to as "J-tubes."

In the test set-up a similar arrangement of "J-tubes" was used for the soda-acid and water tests. For the CO_2 tests the gas was discharged over the tank through a perforated ring header mounted on and close to the top of the transformer tank. The gas test was unsuccessful, probably on account of wind conditions. In this test the fire was finally extinguished with water.

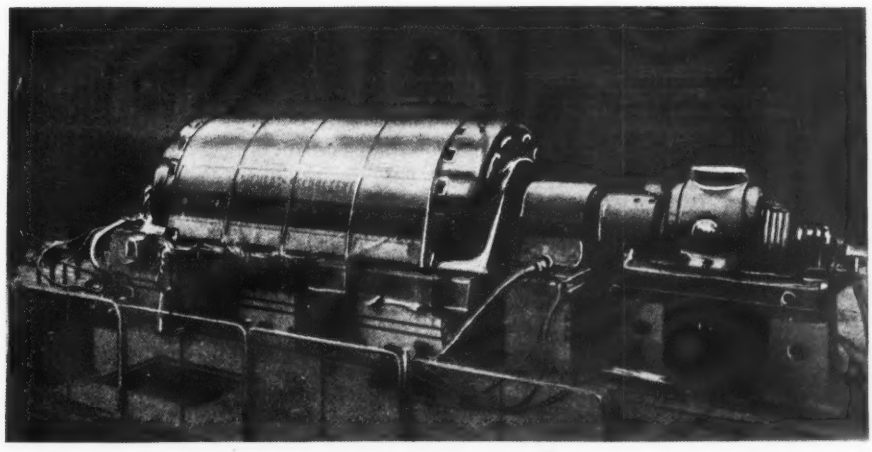
The soda-acid test was fairly successful, but approximately three minutes was required to extinguish the fire. A white deposit found on the equipment after an application of this fluid was an objection to its use. In actual service this deposit would have to be cleaned off before putting the equipment back into service. Connecting the "duo-mixer" in the water line, and the necessity of continually charging the hopper with chemicals, results in some delay in getting started and also requires more attendants to fight the fire.

When water only was applied to the fire, it was extinguished in approximately one-half minute. To check the performance of each test, a second set of similar tests was conducted, and in each case results were similar.

Filtered water is used for the fire lines, the supply being taken from a 100,000-gal. storage tank on a neighboring hill. This tank is filled by two service pumps in the power house taking water from the filtration-plant clear well of 50,000-gal. capacity.

WORLD'S LARGEST HIGH-SPEED GENERATOR

With a capacity of 80,000 kva., this generator establishes a new record for single-shaft, 3,000-r.p.m. machines. It is shown on test at the Siemens-Schuckert Works and is to be installed at Interescant, Belgium. The rotor is 39.4 in. in diameter, 16½ ft. long and is made up of a hollow center forging with the shaft stubs bolted on the ends. The efficiency at 75 per cent power factor is 97.2 per cent.



SELF-PRIMING PUMPS SIMPLIFY AUTOMATIC PUMPING

In April and June, methods of priming centrifugal pumps with vacuum devices and special primary equipment were discussed. This article describes six types of pumps that have the self-priming feature incorporated in them.

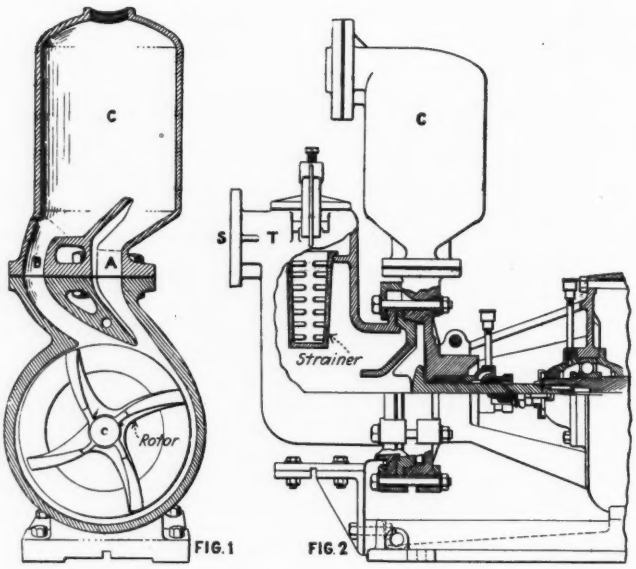
TO INSURE that an ordinary centrifugal pump will always prime, a positive head must be maintained on its suction. This cannot always be done conveniently, and to meet this requirement vertical-shaft pumps may have to be installed in a sump or other source of supply. By installing the pump in the dry above the source of supply, a more convenient arrangement is obtained, any desirable combination of pump and motor may be used and the pump is where it can be readily inspected and maintained.

When the pump is located above the source of supply, some means must be provided to insure it being primed, as discussed in previous articles, or a self-priming pump may be installed. Self-priming pumps may be divided into two general classes: (1) Those that act as hydraulic-type vacuum pumps when started until they are primed and (2) types that have a vacuum-producing device built into them.

Figs. 1 and 2 show a La Bour self-priming pump that belongs in the class No. 1. The suction pipe is connected at *S* to trap *T*. After the pump has been once primed, the trap will retain a supply of water at the runner to insure that the pump will be self-priming.

On top of the pump casing is air chamber *C*, in which air separates from the water when the pump is being primed. The discharge pipe connects to the top of this chamber. Fig. 1 shows the pump impeller and a cross-section through the air separator. When the pump is started, water trapped in its casing is discharged up through passage *A* into the air separator where it is freed of air and flows back through passage *B* into the pump. This process continues until the pump is primed. When prime has been established there is too much water to pass out of opening *A*, consequently the surplus goes out through *B*. This feature prevents recirculation of water in the pump after it has been primed and it operates as a normal centrifugal pump.

Fig. 3 is a cross-section through a Westco self-priming pump. Suction and discharge connections are at the top of the pump, the suction connection being in the position indicated by the dotted circle. Once the pump is filled with water it will be self-priming thereafter. When the pump is started, it delivers water from the casing up through *A* into the discharge pipe.



Figs. 1 and 2—Sections through La Bour self-priming pump

Above the discharge nozzle air separates from the water and the latter flows back to the rotor through passages *B*. When the pump intake has been freed of water, the runner begins to pick up air. This air is carried around to openings *B* where water flows into the runner and causes a mixture of air and water to be discharged up through nozzle *A*. This operation continues until the pump is primed and begins normal operation.

Fig. 4 is a cross-section of a Duriron Company self-priming pump. Pumps of this type are constructed of Duriron or other acid-resistant alloys and are built to operate with or without the self-priming feature. The self-priming parts consist of an air separator *A* connected to the discharge of the volute and a chamber *C* on the suction. When the pump is installed, it is primed by removing cover *B* and filling the priming chamber and the pump with liquid up to the top of strainer *S*.

When the pump is started, liquid is discharged up passage *P* and is diffused by the air separator *E*. The air rises, but the liquid falls back into the bottom of the discharge chamber. From here it flows by a passage, not shown in the figure, back into the priming nozzle *N* and to the intake of the runner. The liquid flowing from the nozzle into the eye of the impeller acts as an injector to draw air from the suction line into the pump. The liquid is recirculated through the priming system until the pump is primed.

While pumping, a small amount of the liquid is returned from the air separator through the priming system. This has the effect of giving the pump an increased head characteristic, as the discharge is decreased. The capacity of the pump is decreased by the addition of the self-priming equipment, as is also its efficiency.

A cross-section of a Domestic Engine & Pump Co.

pump, shown in Fig. 5, is primed by a similar principle to that in Fig. 4, except that it is provided with a means for controlling the water circulated in the priming system. When the pump is started initially the expansion tank E on the discharge and the suction connection are filled with water up to bottom of the suction-line elbow.

As the pump comes up to speed, it discharges water from the suction connection up into expansion chamber *E*, from whence it flows through connection *C* back into the eye of the impeller. When flowing out through regulating nozzle *N*, an ejector action is created that picks up air from the suction and carries it up into the expansion chamber, where it is liberated.

The priming nozzle can be adjusted to give the best results for conditions under which the pump is operating, and when the pump is primed the nozzle may be closed to stop recirculation, if it is not required to keep the pump primed. With the priming nozzle closed, the pump operates as a standard centrifugal pump.

A new method of making a centrifugal pump self priming, that used by the Ralph B. Carter Co., is shown in Fig. 6. The priming chamber *F* and the pump are first filled with water through a cap in the top of the priming chamber. A rubber ball *E* in the suction chamber prevents the water from flowing back into the suction line.

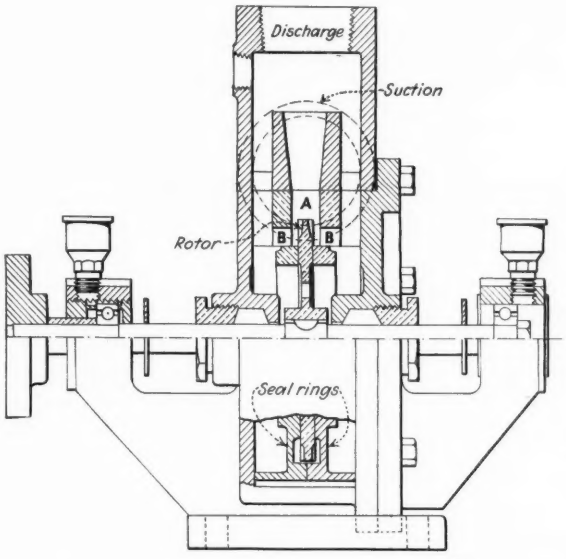


Fig. 3 (Above) — Section through Westco self-priming pump

When the pump is started, it discharges water into the priming chamber. In doing this, disk valve *D* is forced upward and closes control valve *C*.

Since water cannot flow back from the priming tank, the suction chamber is quickly emptied by the pump. Ball valve *E* allows air to flow in to take place of the water and the pump becomes air bound. As soon as the pump has cleared itself of water, valve *D* closes and *C* opens, allowing another charge of water to flow downward through passage *A* to displace the air and reprime the pump. The air discharges up through passages *A* and *B* into the separation chamber and the pump again discharges water into the priming chamber. This operation is repeated until the pump is primed and goes into regular service.

During the priming operation, valve *D* is opened and closed about 60 cycles per minute, each cycle expelling a portion of the air in the suction line. When the pump is primed and goes into normal operation, valve *D* is held open in a position to keep control valve *C* closed and prevents water flowing from the priming tank back to the suction. If sufficient air accumulates in the pump to break its prime, valve *D* closes and the pump is again primed automatically.

Fig. 7 is a cross-section of a Nash Engineering Co. self-priming centrifugal pump for sump and other clear-water services when the pump must operate under a suction lift. On the same shaft with the pump runner *R* is the rotor of a vacuum pump *V* for priming. On the suction of the pump is a chamber, the top of which connects to the intake of the vacuum pump. When the pump is started, the priming pump exhausts air from the suction line and liquid rises into the pump. When this occurs the unit begins to function as a simple centrifugal pump.

The priming pump continues to function and the liquid rises in the float chamber on the suction controller. At a predetermined height the liquid lifts the float and partly breaks the vacuum in the suction-control chamber, unloads the vacuum pump and prevents water from rising high enough to pass into it. This latter feature is particularly desirable where sewage or other dirty water is being pumped.

The air pump is sealed with clean water, and in addition to priming the centrifugal pump it operates continuously, removing gases and air from the liquid entering the centrifugal pump, thus preventing it from becoming air or gas bound. For sewage pumping, a similar

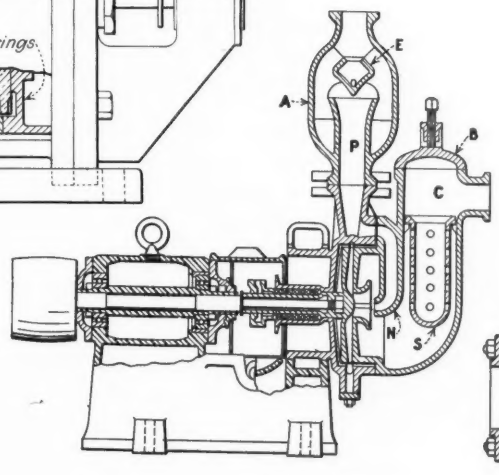
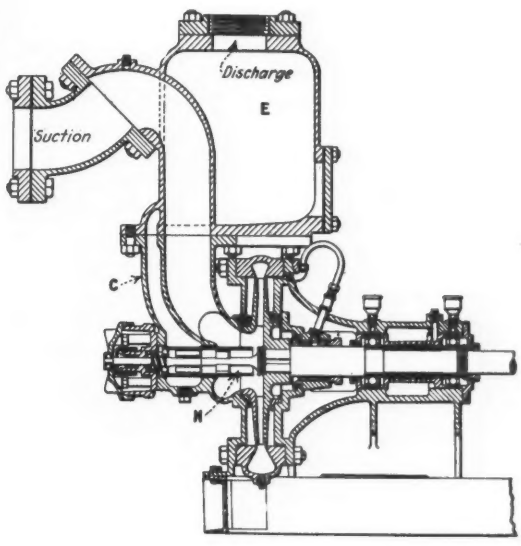


Fig. 4 (Left)—Section through Duriron self-priming pump

Fig. 5 (Below) — Section through Domestic self-priming pump



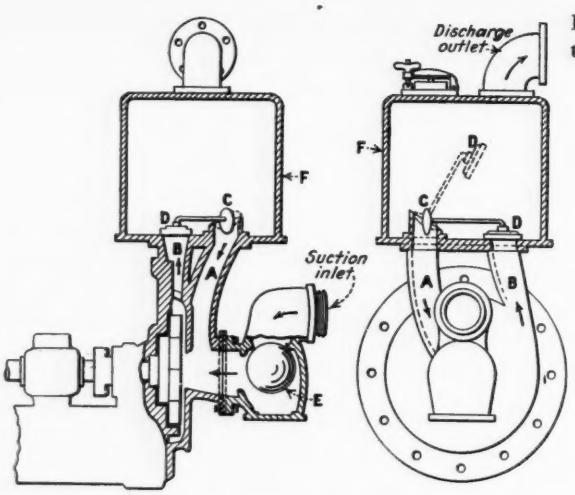


Fig. 6 (Above)—Sections through Humdinger self-priming pump

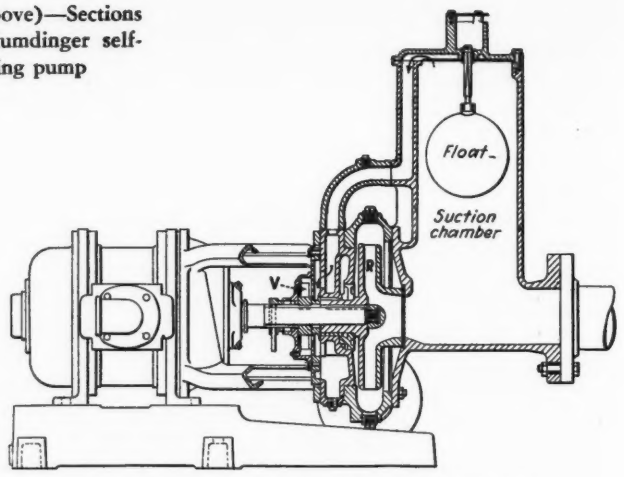


Fig. 7—Section through Nash self-priming pump

arrangement is used except that the centrifugal pump is fitted with a non-clogging type runner.

Other companies manufacturing self-priming pumps that contributed information for this article are the Decatur Pump Co.; the Jaeger Machine Co.; and the Chain Belt Company.

In the first article of this series "Priming Centrifugal Pumps," in April number, credit for the ejector application to priming of centrifugal pumps shown in Figs. 1 and 2 is due Schutte & Koerting Co.

SCHEDULED MAINTENANCE

Reduces Brush Replacement Costs

By RAY BARR GLEN
Oakland, Calif.

Here systematizing the care of brushes, commutators and slip-rings reduced the cost of this work and improved operation in a large power plant

IN A large hydro-electric station, it was apparent that the cost of replacing brushes on commutators and slip-rings might be reduced. To accomplish this, a system was adopted for maintaining the brushes and the surfaces of commutators and slip-rings in first-class condition. Approximately 260 commutator and 100 slip-ring brushes of 13 different sizes were in use in this station.

Complete data for each brush was recorded on letter size, 8½-in. x 11-in. tracings. One tracing was used for each one of the 13 sizes. Five prints were made, three of which were for instruction books, one for equipment record, and one for office file. Thus all brush data was readily available to those having to do with brush maintenance. Effort was no longer wasted in successively recording brush data and subsequently finding that it had been misplaced.

Instructions on caring for and replacing brushes, and for the care of commutators and collector rings, were prepared in considerable detail. In nearly all cases, replacements were to be made when ⅛ in. of useful brush length remained. Brushes were removed from their holders at least monthly, and their surfaces as well as the inside of the holders, were wiped with a rag to remove accumulations of dirt. This was done to insure free radial movement. It was found by test that brush pressure could not be determined with any degree of accuracy by the hand.

Good contact between brushes and commutator or ring surface and the length of brush life largely depend upon correct brush pressure. To make sure that contact pressure was correct, a small spring balance was used to determine the proper brush spring tension for all but the smallest brushes. The brush manufacturer's recommendations for brush pressure were followed, except when there were sound reasons for deviating from them. Most brushes used in this plant were self-lubricating. For those that were not, paraffine was sparingly applied for lubrication when necessary.

Mica in most of the larger commutators was undercut. The slots between the bars were cleaned monthly by means of a home-made tool made from a short piece of hacksaw blade. All commutators, and slip-rings that did not run true, were trued by turning and grinding. Subsequent use of hand grinding stones and sandpaper has not, after four years, appeared advisable. It seems to the writer that the correct way to remove rough spots, and insure trueness is by grinding (turning may first be ad-

Form No. 65

BRUSH-LIFE RECORD
COMMUTATORS

EXCITER No. 4 (Machine) PLANT No. 3 (Station)

Arm. No.	Date of Brush Replacement							
	A	B	C	D	E	F	G	H
1	1-25-28 12-20-28 10-15-29 1-2-30							
2	A	B	C	D	E	F	G	H
3	A	B	C	D	E	F	G	H

Fig. 1—Life-record form for brushes on commutator

Form No. 66

BRUSH-LIFE RECORD
COLLECTOR RINGS

GENERATOR No. 6 (Machine) PLANT No. 3 (Station)

Ring and Row	Date of Brush Replacement							
	1	2	3	4	5	6	7	8
Y A	1-29-28 1-26-29 1-5-30 12-20-30							
	9	10	11	12	13	14	15	16
Y A								
Y B								

Fig. 2—Life-record form for brushes on slip rings

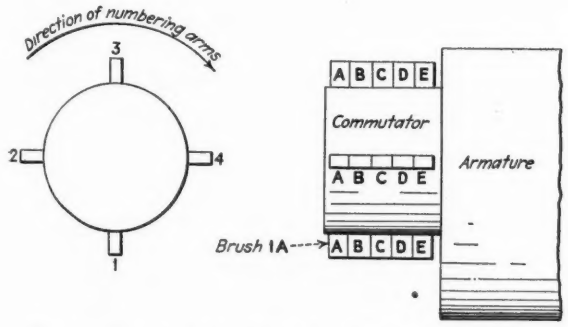


Fig. 3—System of identifying brushes on commutators

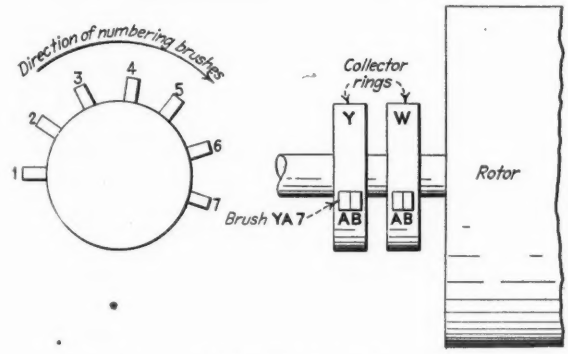


Fig. 4—System of identifying brushes on slip rings

visable) by a rotating wheel. When this work is being done the machine should be revolving at normal speed, and be as nearly as possible at operating temperature. Grinding has not been required for over five years.

Brush maintenance together with other related work, such as cleaning, was definitely assigned. This work on exciters and main generators, which normally could not be taken out of service except after midnight, were assigned to the floorman on watch at this particular time. Readily accessible machines were assigned to individuals composing the operating force. To reduce subsequent clerical work, assignments were made according to a machine number. Machines located in inaccessible places, such as on cranes, were assigned to the maintenance crew. The head operator was held responsible for all work done by operating men during each watch. Work that could not be done properly by the operators was noted on a defect report, and assigned to the maintenance force.

Routine work involving commutators and slip-rings was entered in $8\frac{1}{2} \times 11$-in. loose-leaf forms, kept in the control rooms. These entries were transferred monthly to the permanent equipment records. Life records were kept of exciter and collector-ring brushes. These forms, shown in Figs. 1 and 2, were kept in the control room and transferred to the permanent, equipment-record, loose-leaf binder when filled.

Rigid safety regulations were formulated. Equipment was effectively blocked, and a safety card issued before undertaking work. Touching of live-exciter or collector-ring brushes was prohibited. Deaths have occurred because of contact made with energized excitation circuits.

A uniform system was devised for identifying individual brushes. Brush-holder arms were numbered in a clockwise direction facing the commutator end of the armature. That arm nearest the floor was marked 1, as in Fig. 3. The outer brush-holder was marked *A*. The fourth brush from the outer end on the lowest arm would thus be designated as 1*D*. Collector-ring brushes were numbered in numerical order in a clockwise direction on each ring, as in Fig. 4. Brushes side by side were designated as *A*, and *B*, *A* being farther away from the rotor or armature. The ring farthest away from the rotor was designated as *Y*. Three-phase rotor slip-rings were known as *Y*, *W*, and *X*. Designations were stamped or painted on arms and holders.

A small metal tool box with hinged cover was purchased to facilitate replacing brush. In this box was kept the spring balance for checking brush-spring tension. Undercutting tools, screw drivers, wrenches, pliers, and a small pair of tin shears, the latter for cutting sandpaper into strips of a width suitable for the various sizes of brushes, were provided in the tool box.

First-quality portable hand lamps were originally used to provide local illumination for brush work, and cleaning, but these were soon supplemented by a 300-watt portable flood lamp. This lamp gave such good illumination that a portable hand lamp was used only while making careful inspections. Additional flood lamps were soon obtained for use in wheel pits, and while major overhauling or repair jobs were under way.

In this station, the exciters were direct-connected, and their brushes wore away quite rapidly and made frequent replacements necessary. It was found possible, however, to use brushes $\frac{3}{8}$ in. longer. This slight change not only increased the interval between brush replacements, but decreased the cost, since the copper shunts became a smaller percentage of the total expense.

AUTOMATIC ZEOLITE SOFTENER

THE automatic zeolite water softener, latest step in continuous development of zeolite equipment for softening water, meets the demand for a softener that is self-regenerating and that insures softened water at all times.

Zeolite is a granular, insoluble material. The water softening is accomplished merely by passing the water through a bed of this zeolite. After the rated capacity of the zeolite has been reached the accumulated hardness must be removed by regeneration. This is done by passing a solution of common salt brine through the softener. Regeneration is usually preceded by backwashing in order to cleanse and regrade the bed. The cycle of operations, therefore, consists of softening, backwashing, salting and rinsing.

In manually operated zeolite softeners, seven or more individual valves are needed to control this cycle of operations. Simple as these operations may be, it is necessary to regenerate on time when the softening run has ended. Also the backwashing, salting and rinsing should obviously be carried out most economically, with a minimum of salt and water. Automatic softeners accomplish these results.

In place of the nest of individual valves used on manually operated softeners, the automatic unit employs a multi-port single valve, having a rotary flat disk with ports so arranged that by turning the disk to four successive positions, the four operations of a complete cycle are carried out. The control mechanism is so arranged that the duration of each operation of a complete softening cycle can be separately adjusted and controlled.

The flat rotary valve employs a new principle of using a hard-rubber valve disk, rotated in close contact with the stationary bronze port plate. This insures tightness, easy turning and ruggedness. Fig. 4 illustrates a cross-section of this multi-port valve. Regeneration is initiated by the meter and carried through its various steps by rotation of this valve by the electric motor.

Softening—During the softening run, the automatic valve remains in the softening position until a predetermined volume of water is passed through the meter. The meter then closes the control circuit, which starts the valve motor. The motor rotates the valve to the backwash position, then the motor stops and the valve remains in that position until the end of the operation.

Backwashing—An upward flow of water through the zeolite bed removes dirt from the top of the bed and at the same time hydraulically grades the zeolite granules so that the finer grains are on top. These finer grains assist in uniform distribution of water and brine. Means to control the backwash operation are time switch and rate-of-flow controller. This rate-of-flow controller maintains a definite head of water behind an orifice located in the sump. It maintains this constant rate of flow irrespective of variations in pressure that may occur in the supply line. With fixed rate of flow and fixed interval of time, a definite automatic control of the volume of water employed in the operation is obtained. After the multi-port valve has been in the backwash position for a predetermined interval the time switch energizes the valve motor, which turns the valve to the brining position.

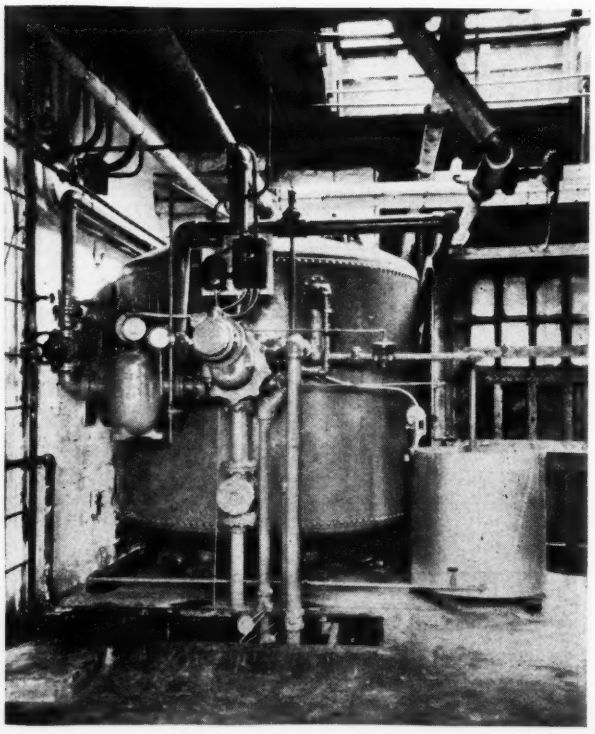


Fig. 1—Commercial installation of automatic zeolite softener

Brining—During the brining operation, salt solution is introduced into the softener. The means for controlling the volume of brine employed is a float switch in the brine-measuring tank.

Introduction of the brine is carried out by a hydraulic ejector. A small pipe connected to the multi-port valve is placed under pressure when the valve is in the brining position. This water pressure actuates the diaphragm-operated valve on the suction side of the brine ejector. The ejector lifts the brine from the measuring tank and introduces it into the softener. When the brine has reached a predetermined low level in the measuring tank, the float switch closes the control circuit. This starts the valve motor again, and the valve is then rotated to the rinsing position.

Rinsing—In the rinsing operation, the brine is driven down through the zeolite bed by fresh water and rinsed to the sewer.

As in the backwashing step, so in the rinsing step the time switch controls the duration of rinsing and the rate-of-flow controller controls the rate. At the end of the rinsing period, the valve motor is started again and rotates the valve back to the original softening position.

Advantages may be summarized as follows:

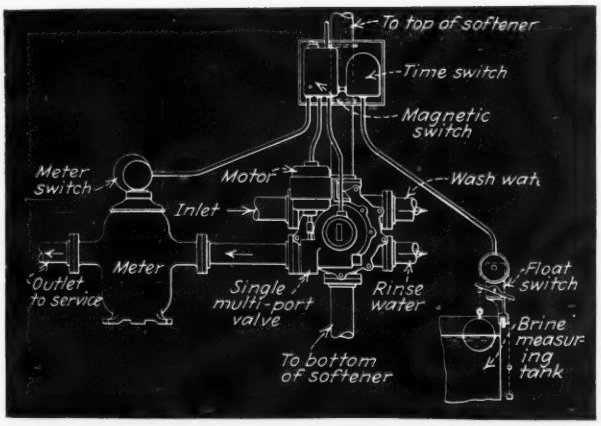
1. All operations are automatically carried out, thus saving attention.

2. Regeneration takes place on time, so that the softener is never, due to negligence, run beyond its softening capacity. The production of nothing but completely softened water is assured.

1. SOFTENS
2. BACKWASHES
3. BRINES
4. RINSES

WITHOUT HUMAN CONTROL

By S. B. APPLEBAUM
Vice-President, The Permutit Company



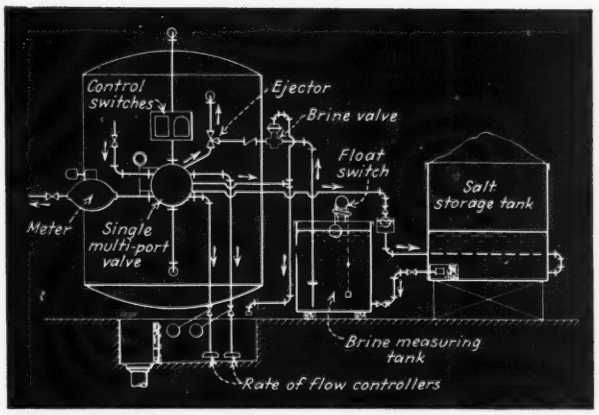


Fig. 2 (Top)—Arrangement of control devices. Fig. 3—Arrangement of piping and equipment

3. Salt is saved by avoiding regenerating before the end of a run and by mechanical measuring of salt-brine.

4. Mechanical control of backwashing and rinsing avoids waste of water in these operations as well as the washing out of zeolite to the sewer and assures the maintenance of the zeolite in a clean, active condition.

5. Slow turning of the automatic single valve assures gradual increase of rate of flow at start of each operation. This preserves the zeolite and gravel supporting beds from any shocks or disturbances.

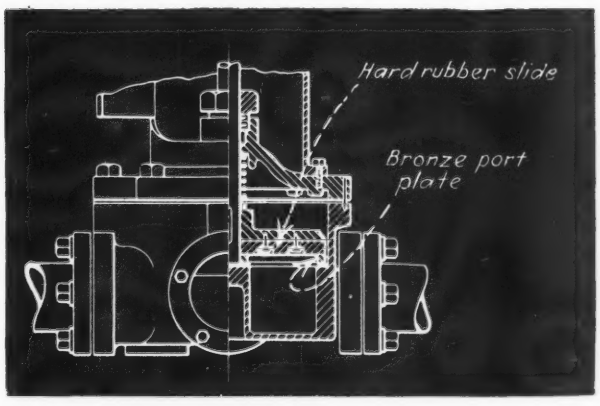
6. Automatic softeners may be built of smaller dimensions than the manually operated type. Manually operated softeners are usually made large enough to run for 12 to 24 hours between regenerations to save the operator's time by reducing the frequency of regeneration. With self-regenerating automatics, the softener may be smaller and yet produce the same total daily soft water output as the larger manually operated softener without the excessive attention which a smaller manual softener would require. Thus a saving in first cost as well as in operating cost is realized.

7. The automatic features can be applied to any existing manual softener by replacing the nest of individual valves by the motor-operated rotary valve and adding the control devices.

Many factories have one operator assigned to a multiplicity of duties. When he reaches the softener he may find the softening run not yet complete, but to avoid overrunning the softener he may be tempted to regenerate prematurely and thus waste salt and water. The automatic softener relieves that situation.

Isolated railroad water stations may not have a regular attendant, or may have one operator making occasional visits. Large water-treatment plants containing a number of zeolite units, together with other water-treatment equipment, may be too much for one operator to handle efficiently. In either case the self-regenerating unit is suited. These and other similar situations are responsible for development of the automatic softener.

Fig. 4—Cross-section of single multi-port valve



PRACTICAL AIDS TO OPERATION

Combination Manual and Automatic Feed-Water Regulation

In a power plant supplying a textile mill load, difficulty was experienced in regulating the feed-water level. The water level would jump from 4 in. in the gage glass to a full glass when the steam engines suddenly picked up a load of approximately 1,000 hp. The reverse would happen when the load was dropped.

Setting the feed-water regulator generator was a problem. If set to carry the water level at one-half a gage glass, the boilers would prime when starting the engines.

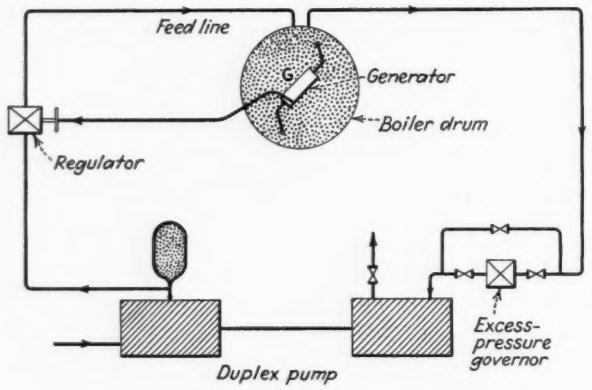


Fig. 1—Original arrangement of feed-water system

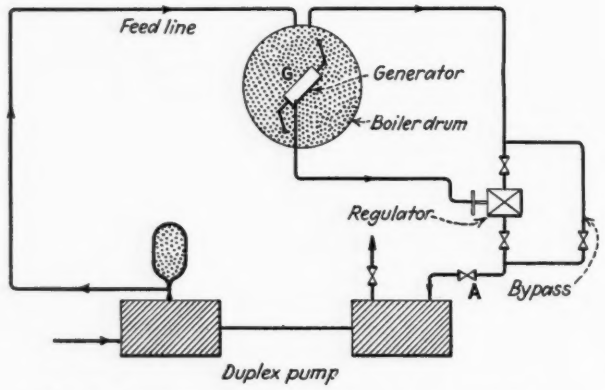


Fig. 2—Feed-water system arranged for manual and automatic control

If the water was at that level just before shutting down the engines, when they were stopped the water would disappear from the glass because of the water circulation in these boilers, which were of four-drum, water-tube construction.

To insure safe operation, water level had to be down to 4 in. in the gage glass when starting the engines and at three-quarters glass when the engines were stopped. To accomplish this the boiler feed pumps were manually controlled during the starting and stopping period, and automatic control was used during normal operation.

Fig. 1 shows the original hook-up of the boiler feed-water control. Fig. 2 shows the arrangement now used. The generator *G* is set to carry the water level at three-quarter gage glass. When starting the plant, steam to the feed pump is throttled by closing valve *A* to a point at which it is only one-eighth turn open, 5 min. before the whistle blows, which slows the pump down to give 4 in. of water in the gage glass.

Five minutes after the starting whistle blows, valve *A* is opened to one-quarter turn and allowed to remain that way during normal operation of the plant. Under this condition the automatic regulator maintains the water level in the boiler at one-half glass.

At 5 min. before the stopping whistle is to blow, valve *A* is opened to three-quarters of a turn, which causes the water level in the boiler to rise to three-quarters of a glass. This takes care of the sudden drop in water level when the engines are shut down. Valve *A* is left three-quarters of a turn open until the water level has returned to a three-quarter glass, all load off, when the boilers are ready for blowing down.

The boiler operators have, of course, had to be schooled into this routine, but the change in operation has relieved their trouble considerably.

Toronto, Ont. Leslie W. Ross

Furnace Doors Used for Explosion Relief

Serious accidents have resulted from firebox explosions or flarebacks in boiler furnaces equipped to burn oil, pulverized coal or gas. Boiler settings of these types usually include a number of cast-iron cleanout doors. It will in most cases be good practice to remove the latches from these doors, or at least from the larger ones, to prevent them from being latched shut. The hinges may be adjusted with just enough friction so that slight positive furnace pressures will not cause them to open. If a serious flareback occurs they will open instantly and relieve the furnace of the excess pressure.

In a pulverized-coal equipped boiler plant, two large ash-removal doors were latched shut in the front of the lower boiler setting. When the boilers were started up one day, the burners on one of the boilers were slow in igniting and the furnace must have filled with a powdered coal and air mixture. When ignition occurred, the furnace contents exploded with such force that a long flame backfired at the burners and several bricks were blown from the boiler setting. Similar incidents, some of them resulting in accidents, have led to strict orders in one plant to leave furnace doors unlatched.

Milford, N. J. Harry M. Spring

Starting Wound-Rotor Motors After a Power Interruption

Necessity for quick restoration of service to auxiliaries in a power station after an interruption is obvious, particularly service restoration to forced- and induced-draft fan motors. As these motors in many instances are variable-speed, wound-rotor type, it is necessary to limit the inrush current at starting. Protective equipment can be provided that requires the controller to be returned

to the starting position after an interruption, but necessitates that after an interruption each motor be started separately. Such a method entails a loss of time in getting the motor back into service and requires additional help where several motors are involved.

To overcome this condition in one plant where the control of the motors was centralized, a separate resistor was added to each motor resistance. Each of the resistors, during normal operation, is short-circuited by a contactor energized from a low-voltage relay connected to the primary circuit of the motor. As soon as the main breaker is closed, the voltage relay is energized, and it short-circuits the separate resistor. The motor is then started in the usual way, controlled by push button from the boiler room.

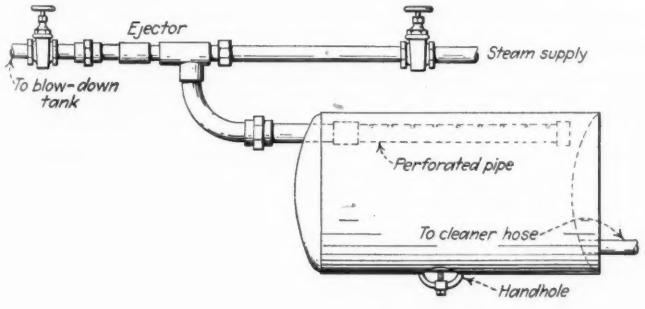
When a power interruption occurs the emergency resistor section is automatically inserted. When power is restored the motor starts and accelerates to its previous speed without attention from the boiler-room operator. There is a time delay included in the voltage relay to allow the motor to come up to speed before the resistor section is cut out.

Brooklyn, N. Y. C. O. VAN DANNENBERG

Steam-Jet Vacuum Cleaner For Power Plants

A GOOD vacuum cleaner is useful for removing the dust from boiler tops, overhead walkways, steam pipes and roof girders without distributing dirt all over the plant. With a rubber nozzle attached to the suction hose, dust can be removed from moderate-voltage busbars and switch gear while alive. Soot and cinders can be removed from the cracks between sectional water-tube boiler headers and around the setting, a job which cannot be performed satisfactorily with any other tool. Clogged cinder chutes can be opened by slowly feeding a small suction hose into the cinders and gradually removing them, instead of packing them tighter as frequently occurs when a water hose is used.

A vacuum cleaner for this purpose can be purchased, but when the money is not available, a suitable cleaner



may be constructed with a small dirt-collecting tank and a $1\frac{1}{2}$ or 2-in. steam ejector, as in the diagram. The discharge from the ejector may be turned into the boiler blow-down tank, which is usually provided in power plants.

If more than one hose connection is necessary, it is desirable to purchase regular vacuum cleaner connections, as they are provided with spring covers which automatically close the outlets not in use. Also it is desirable to purchase regular vacuum cleaner hose, preferably protected with woven-steel bands, as it will give much more service when dragged over concrete floors.

A floor tool, handle and hose connection are necessary. A bristle-brush floor tool gives good results, although when the vacuum is limited a small carpet tool will remove the dust more rapidly. A round hair brush is handy for dusting pipes and girders, and with a tapered rubber nozzle all the necessary tools will be provided.

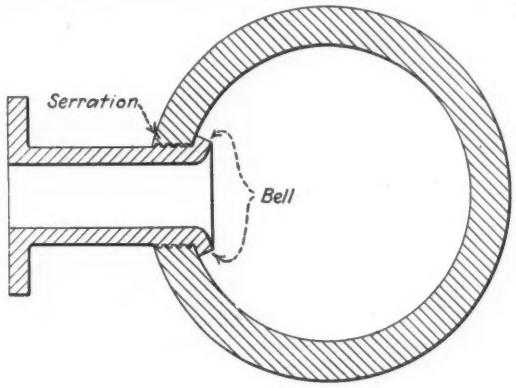
In piping the cleaner, unions should be provided so that the steam syphon can be removed for cleaning, while bends should be made with long-radius drainage fittings, bent pipe or conduit elbows.

Altoona, Pa. A. R. MARKLAND

Safety-Valve Connection Fails on Superheater Header

A SUPERHEATER designed to operate with steam at 800 deg. F. and 800 lb. per sq.in. pressure, failed at a pressure of 675 lb. The header was of forged steel machined all over and was fitted with two pipe connections, one for the safety valve and one for a stop valve. These pipes were connected to the header as shown in the figure. They were serrated on the ends before installation and were bell mouthed on the inside of the header. This apparently produced a satisfactory joint, as the construction passed the necessary hydraulic tests.

After the boiler went into service and while operating under a pressure of 675 lb., the joint between the safety



valve pipe and the header failed. The escaping steam made it difficult to shut off the steam but no damage was done beyond the destruction of the joint.

Investigation showed that the serrations had not been completely filled when the joint was expanded, and the bell mouthing was not considered sufficient for the pressure. It is open to doubt if serrated and bell mouth joints are wholly reliable for high pressures. Alternate heating and cooling causes a certain amount of movement, and this may in time destroy the efficiency of the joint. When the joint was remade, it was done by welding.

Herts, England. W. E. WARNER

Cold Glue Used as Belt Cement

FOR MANY years in our plant we used a leather-belt cement that was applied hot. One day a glued joint on the exciter belt broke and not having any regular belt cement on hand and needing the generator, I decided to try cold Russian glue. This is the ordinary kind of glue

used for woodwork. It was applied to the belt with the hope that the joint would last until we could get some regular belt cement.

It is now two years since we made that joint, and there is no sign of weakening. The pulley on the exciter over which the belt runs is 4 in. in diameter and operates at 1,700 r.p.m. We have in the last year and a half made several jonts on other belts with the same kind of cold glue and all have been satisfactory. I feel that it is a waste to bother with all the preparations of using hot glue.

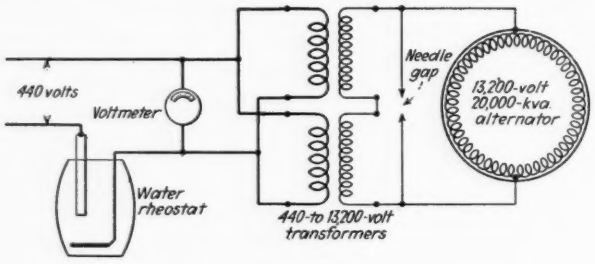
NELS HILSEN

Duluth, Minn.

Auxiliary Transformers Used for High-Potential Testing

THIS is a description of the procedure followed when making high-potential tests in one hydroelectric plant operating 13,200-volt, 20,000-kva. alternators. In this plant it has been necessary to rewind each of the alternators because of insulation failures. It was necessary to do this winding in place, and to subject the new windings to a high-potential test of 27,000 volts. No facilities were available for directly obtaining this voltage or for measuring it.

Two banks of three single-phase, 100-kva. 13,200 to 440-volt transformers were available for auxiliary station power. One bank was disconnected, and two units removed from it and connected in parallel on the low-voltage side and in series on the high, as in the diagram. A water rheostat was used to control the voltage applied to the low side. The rheostat consisted of a barrel filled with salt water; an iron plate in the bottom of the barrel provided one terminal. A movable terminal was provided for the rheostat by attaching a cable to a rope by means of which it could be raised or lowered.



A 440-volt source was available at the auxiliary board. A voltmeter connected across the primary terminals of the testing transformers checked the applied voltage. Across the secondary terminals a needle gap was connected. The needle gap was set at 1.430 in. for a break-down potential of 27,000 volts. Before connecting the windings to be tested in the circuit, the outfit was tested to predetermine the primary applied voltage necessary to break down the needle gap with its setting for 27,000 volts.

With the primary circuit closed, the applied voltage was gradually increased by means of the water rheostat until the needle gap flashed over. The needle gap was reset and again broken down several times, each time the value of the applied voltage was read at the instant of breakdown. When the proper value of applied voltage had been predetermined, one secondary lead was connected to the generator leads, the other was connected to ground. The spark gap was set 10 per cent higher than the required voltage and was left in the circuit as a precautionary measure. With these connections completed, the primary voltage was slowly increased to the predetermined value and allowed to remain there for one minute.

When using this method of testing, care must be taken to use transformers of sufficient capacity. From the experience in testing the 20,000-kva. alternators, it was decided that for these machines about 7.2 kva. were required for each 1,000-kva. machine capacity. While this method of testing was used in a particular case, the principle can be used for any similar situation.

Tapaco, N. C. S. B. STOUGHTON

CURRENT COMMENT

Welding Pipe Joints to Prevent Leaks

I FAIL to see why the method of welding a flanged pipe joint to prevent leakage through the threads, described by D. J. Taylor in the May number of *Power*, page 270, should be an improvement on the regularly accepted way of welding the threads to the pipe at the back of the flange hub, on the outside of the pipe. On the contrary, it would seem that the advantage is in favor of the standard practice in that a faulty weld may be repaired without dismantling the flanged joint.

Mr. Taylor also mentions placing a metal ring in the groove. I wonder if he ever tried it? My guess is that the ring would cause rather than prevent leaks. The proper way to increase gasket pressure is to use a standard tongue-and-groove joint.

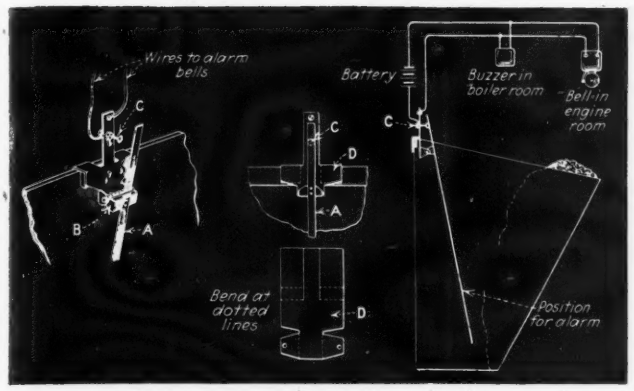
Generally I find that good pipe threads made up with the proper cement will not leak under pressures up to 300 lb. per sq.in. A case of leaky threads in a 150-lb. line was brought to my attention some two years ago. Investigation showed that the line was carrying a caustic-soda solution which is a solvent for lead. The screw threads were made up with a red-lead or white-lead cement, hence the leaks. When the make-up cement was changed to Smooth-On, no more trouble was experienced with leaks.

Pittsburgh, Pa. BERNARD KRAMER

No-Coal Alarm for Pulverized-coal Feeder

I READ with interest the article describing a no-coal alarm in the February *Power* and agree with Mr. Spring that considerable trouble is caused by coal sticking in the pipes and hoppers. The diagram shows a device which I am now using and which will not tend to clog the hopper. As every operating man knows, even a small stick will cause stoppage in the hopper if the coal is a little damp.

The alarm consists of a flat steel arm *A*, $\frac{1}{2}$-in. wide and $\frac{1}{8}$-in. thick, of a length about equal to the depth of the hopper. This arm is pivoted at *B* on a bracket *D*, which is cut and bent from a piece of steel 1/16-in.



thick, made to slip over the edge of the hopper. A coil spring is slipped over the pivot pin and is bent to make the arm swing out into the hopper and make contact at *C*, which is the insulated contact. For the alarm circuit a buzzer is used in the boiler room, and a bell in the engine room, operated by two dry cells.

When there is coal in the hopper, arm *A* is held against the side of the hopper, and the alarm circuit's open. If the hopper is empty or the coal sticks, the arm swings to the right and closes the alarm circuit. No matter how wet and sticky the coal may be, the hopper always empties on the vertical side, which is just above the feeder opening. If the coal sticks, it is on the sloping side and takes a form somewhat similar to that indicated by the dotted line and allows the alarm contact to close.

Milwaukee, Wis. L. M. LARSON.

Increasing the Power of a Steam Engine

IN THE April number of *Power,* S. M. Quinn replies to the query of one of your correspondents who asks how to increase the capacity of an engine. Whenever possible, increasing the speed will increase the power of the engine, but aside from the flywheel limitation, there are other restrictions. If the machine is directly connected to a generator or a drive shaft, its speed cannot be changed.

There are other methods of increasing the power of an engine. One is to boost the initial steam pressure, when operating conditions will permit. A machine operating at 100 lb. initial pressure will produce 50 per cent more power at 150 lb. There is little increase in heat per pound of steam with an increase in pressure, but the heat units per cubic foot rises rapidly. At 100 lb. absolute, the heat content of steam is 270 B.t.u. per cu.ft., while at 150 lb. the corresponding figure is 400.

Some engineers are under the illusion that an increase in superheat produces a like effect. This is not so, as the gain in heat units due to higher superheat is more than offset by the increased volume, and the heat units per cubic foot decrease with a rise of superheat. Although there is an increase in efficiency, the capacity of the engine is practically unchanged.

The power of an engine can also be increased by a reduction of back pressure. If the engine in question is non-condensing, its capacity can be increased by changing it to condensing. Some alterations in the exhaust-valve ports may be necessary. An increase of about 4 per cent in power may be expected for each inch of vacuum.

Another method of increasing the power of an engine is by altering the admission valve setting. By delaying the cut-off, greater power can be obtained, and in extreme cases the machine can be made to take steam full stroke. In doing this the engine's efficiency is sacrificed, which may be of little consequence if the exhaust steam can be utilized.

Chicago, Ill. N. T. PEF.

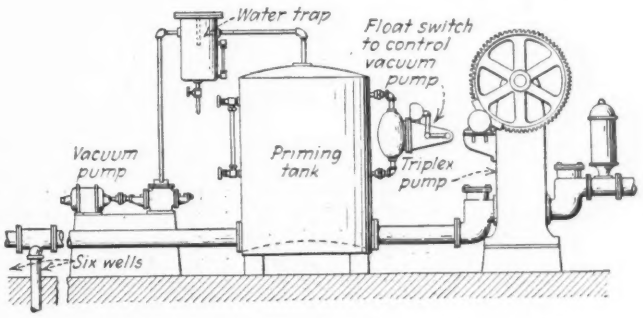
Priming Equipment Installed on Plunger Pump

ENGINEERS in general believe that positive-displacement pumps are self-priming. In most applications, if both pump and suction line are in good condition, this type of pump can be depended upon to prime and remain primed while in operation. As pointed out in the article, "Vacuum Producers for Priming Centrifugal Pumps," in the April number of *Power,* conditions may exist where positive-displacement pumps are not self-priming. This brings to mind an experience of that kind.

A large vertical, triplex, single-acting plunger pump took its water supply from six wells about 30 ft. deep through a suction line about 300 ft. long. The suction lift in this case was about 25 ft. It was found that the pump would lose its prime on one cylinder. After trying the usual methods of overcoming this difficulty, we decided that probably there were air leaks in through the wells, and possibly others in the long suction line that could not be detected.

This decision led to the installation of a priming equipment as shown in the figure. A tank 3 ft. in diameter by 4 ft. high was placed in the suction line. A float-operated switch was installed on the tank to control operation of the vacuum pump.

The float switch was located so that with about 3 ft. of water in the tank the vacuum pump would be shut down. When air accumulated in the tank to cause the water to fall about one foot the float switch closed and started the vacuum pump to restore the 3-ft. water level. In this way a positive head was maintained on the pump suction at all times. Any air entrained in the water was



liberated in the tank and removed by the vacuum pump. After installation of the priming equipment, no further trouble was experienced with the pump losing its prime.

Trouble was experienced with moisture being drawn with the air over into the vacuum pump. This difficulty was overcome by installing a water trap as shown. The trap consisted of a container with a baffle extending down into it. Because of the decreased air velocity in the container and the whirling action produced by the baffle the water was deposited in the container and was drawn off periodically as it accumulated.

J. MOOSBRUGGER,
New York City *Mechanical Engineer, Suburban Engineering Company*

READERS' PROBLEMS

PITTING OF WATER HEATER—*I have two closed hot-water heaters, one of 4,500 gal. per hr. capacity and the other of 2,500 gal. per hr. About 50,000 gal. of water treated in green-sand zeolite softeners passes through the heaters in eight hours. Considerable trouble is experienced with pitting of the shell plates and rivets in the heaters. Various treatments to prevent this pitting have been tried without success. We had the heaters sand-blasted and painted with two coats of Apexior. A first-class job was obtained, but three months later inspection showed that the paint had corroded through and pitting started again. Silicate treatment was also used without success. Any suggestions for overcoming this trouble will be appreciated.*

(The following reply was prepared by W. J. Ryan, Water Service Laboratories, Inc., New York City—Editor.)

Sodium silicate has been used with success in many cases similar to this one, but the results obtainable often depend on how the treatment is applied.

If the silicate is added to the water in intermittent doses, it may not accomplish much. It should be fed continuously so that every gallon of water gets its small charge of silicate. This can best be done by means of an automatic feeder which can be obtained from any of the manufacturers of water-treating apparatus. The amount required is about ½ lb. per 1,000 gal. Particular attention should be given to neutralization of all the carbonic acid. This small amount does not affect the potability of the water and should not be detrimental in any way.

Another method sometimes used is to add sodium sulphite to the water in sufficient amount to combine with the free oxygen in solution, thus forming sodium sulphate. Every part per million of free oxygen in the water requires 7.9 parts per million of sodium sulphite. If the water contains 8 parts per million of free oxygen, the required amount of sodium sulphite as NA_2SO_3 will be 63 ppm., which is equivalent to 0.53 lb. per M gal.

A special feeder would be required for sodium sulphite as well as for sodium silicate and it should be possible to obtain a feeder that would do equally well for either material. The companies that furnish these feeders can also furnish testing apparatus with instructions for making the proper tests to control treatment.

Another alternative would be to try a different protective coating. Cement has given good results in some cases. Portland cement is mixed with water to about the consistency of whitewash and applied with a brush after the metal has been thoroughly cleaned.

Still another alternative that might be tried as an experiment is to by-pass a little hard water around the softener, giving a resultant mixture that has a hardness of about 20 to 30 parts per million. It has been found that in some cases the presence of a little hardness in the water counteracts its corrosive tendency. This suggestion involves the nullification of some of the benefits for which the softener was installed and should only be tried if other means have failed to check the corrosion.

Adding some hardness to the water by by-passing the softener may cause some expense, as, for instance, by increasing the soap consumption in a laundry, or by making necessary boiler cleaning, etc., in a power plant. Or there may be other detrimental results, depending on the use to which the water is put.

VOLUTE AND TURBINE PUMPS—*What is the difference between a volute and a turbine pump?*—R.B.S.

Centrifugal pumps may be divided into two general types, volute and turbine. The former has a spiral or volute casing to guide the water from the impeller to the discharge pipe. The spiral has a gradually increasing cross-section to convert the velocity head of the water leaving the impeller into pressure. The volute is free from any vanes or devices for guiding the water other than its spiral form.

The impeller of a turbine-type centrifugal pump is provided with a circular diffuser that contains guide vanes to form gradually increasing passages. In these passages, a large part of the velocity head given to the water by the pump impeller is converted into pressure by the time it reaches the discharge.

High- or Low-Pressure Steam For Heating Water?

Answers to May Question 1

The Question

WE ARE using steam at 90-lb gage pressure in pipe coils to heat water in a 2,000-gal. uninsulated steel tank. The tank is filled three times a day with water at about 60 deg. and heated to 190 deg. in about one hour. Will any saving of steam result and, if so, about how much if a reducing valve is installed to reduce the steam pressure to 25 lb. before the tank coils?—C. R. S.

Power From Heating Steam

NO SAVING in steam could be accomplished by putting the 90-lb. pressure steam through a reducing valve and lowering it to 25 lb. before it enters the heating coils. There is, however, an excellent possibility to develop some very useful power at almost no cost.

Some years ago at one plant, we had a lot of water to heat every day. This had always been done with live steam. To get a more efficient layout we put the live steam through a small piston-valve steam engine which was connected to a 3-phase generator. The exhaust from this engine, which was at a pound or two pressure, was discharged into the heating coils. In other words, we used the water heating equipment as a kind of surface condenser. The generator we synchronized with the plant power supply and we obtained many thousands of kilowatts per annum at extremely low cost.

In the question asked by C. R. S., there is not sufficient detail on which to figure whether anything could be done along this line. Assuming that the water does not have to be heated in one hour, but can be spread more uniformly over, say, two and a half hours, then it offers interesting possibilities. In this case some approximate figures could be made that would interest the management.

The total amount of water heated per day is just over 50,000 lb., and to raise this through a temperature range of 130 deg. F. will take over 6,500,000 B.t.u. In addition, there will be the heat loss due to radiation from the steel heating tank, which is probably about 7 ft. in diameter by 7 ft. high, and this radiation loss may be somewhere around 170,000 B.t.u. per day. Thus the heat demand during the working day will be in the neighborhood of 6,700,000 B.t.u., and that will call for about 6,200 lb. of 90-lb. steam.

If the necessary changes are made to heat the water with exhaust steam, then we will need about 7,300 lb. of steam, but, see what can be obtained for the additional 1,100 lb. of steam. We could get as much as 230 hp.-hr., which is about 28 hp. all day during the 8-hour day. This power could be used for any purpose, such as power generation, line-shaft driving, grinding, pumping or any purpose whatever. Notice that under these conditions you are really getting a horse power for just over 4.8 lb. of steam. This is a power cost so low that the management cannot afford to disregard the engineer's recommendation.

Moline, Ill.

GEO. P. PEARCE.

Time to Heat Water Increased

WHEN steam at 90 lb. gage is used to heat water from 60 to 190 deg., the logarithmic mean temperature difference is about 199 deg. If the steam pressure is only 25 lb. gage, the logarithmic mean temperature difference will be only about 131 deg. Evidently then, if one hour is required in the first case, the time required in the second case will be 199 ÷ 131 or 1.52 hours.

Since the tank is not insulated, the loss from the surface by radiation will be about 50 per cent greater due to the longer time required for heating. On the basis of a surrounding air temperature of 60 deg. the logarithmic mean temperature difference will be 26.7 deg. A tank of this size would have an external area of say 260 sq. ft. The loss based on a heat transfer coefficient of 3 would be in one hour 3 × 26.7 × 260, or 20,800 B.t.u. If

the lower pressure were used and the time increased, the loss would be 1.52 times as much, or 31,600, which is an increase in the loss due to radiation of 10,800 B.t.u. If the condensate in each case leaves at 200 deg. the heat given up per pound of steam is 1,187 — 168 or 1,019 B.t.u. The lower-pressure process will require 10,800 ÷ 1,019 or 10.6 lb. more steam or about 7 lb. per hour more than the high-pressure process. If C. R. S. wants to save steam, the proper thing is to cover his tank with a good insulating material. He can save about 15 lb. of steam per hour by so doing, since he can easily prevent 75 per cent of the present loss.

Corvallis, Ore. W. H. MARTIN.

Steam Saved 6.5 Per Cent

AT THE present time, steam at 90 lb. gage is being used presumably dry and saturated. At this pressure, the heat content per lb. of dry saturated staem would be:

Sensible heat per lb.	301.8 B.t.u.
Latent heat per lb.	885.3 B.t.u.
Total heat per lb.	1,187.1 B.t.u.

Heating 2,000 gal. of water in one hour from 60 to 190 deg. F., a temperature rise of 130 deg. F., requires a heat input from steam of 2,165,800 B.t.u. This heating is done indirectly in pipe coils submerged in the tank, therefore only the latent heat is removed from the steam if the coil is provided with a trap in working order. Hence, there is required (2,165,580 ÷ 885.3) B.t.u. or 2,440 lb. of steam per hr. at 90 lb. gage pressure.

If a pressure-reducing valve were installed, set to deliver 25-lb. gage pressure steam, the reduced-pressure steam would still have the same total heat per lb. as before, hence the heat division per lb. of steam would be, at 25 lb. gage:

Sensible heat per lb.	235.6 B.t.u.
Latent heat per lb.	933.3 B.t.u.
Superheat	18.2
Total heat (as before)	1,187.1 B.t.u.

Since the latent heat and superheat is dissipated to the water being heated, the steam required for the same duty as before would be (2,165,800 ÷ 951.5) B.t.u. or 2,280 lb. per hr.

It should be noted, however, that in either case, the economy goes back to the coal pile and if the condensate at 90 lb. or 25 lb. were to be returned to the boiler without any heat loss enroute, there would be no fuel saving. In the case of 90 lb. steam, the heat in the condensate would be 301.8 B.t.u. per lb. and at 25 lb. this would be 235.6 B.t.u. If the condensate is wasted by draining to the sewer, the operation at 25 lb. pressure would be more economical than at 90 lb. to the extent of 6.5 per cent saving in heat.

Presumably C. R. S. feels that there is sufficient surface in the coil to permit operating at the reduced pressure, which of course, means that the effective steam temperature will be 266.9 deg. F. at 25 lb. instead of 331.2 deg. F. It should be remembered that in any heat transfer the heating surface required is dependent on the temperature difference between the two mediums.

Chicago, Ill. H. J. P.

Steam Saving Depends on Trap

WHEN steam is expanded through a reducing valve its total heat content does not change, and the same number of pounds of steam will be required to heat the tank of water whether the steam is used at 90 lb. or reduced to 25 lb. as suggested.

There is, however, a possible chance of a slight saving, by using the lower-pressure steam, not due to any change in thermal efficiency but directly attributable to the method by which the condensate is drained from the coils. If a trap of the common float or bucket type, which will discharge condensate at saturation temperature regardless of pressure, is used, the discharge temperature at 90-lb. pressure will be 331.3 deg. and at 25-lb. 267 deg. Approximately 64 B.t.u. more heat would be given up per lb. by the lower-pressure steam, only the total latent heat being utilized, which at 90-lb. gage and 100 per cent quality is 885.4 B.t.u. To raise the temperature of 2,000 gal. of water 130 deg. $\frac{2{,}000 \times 8.345 \times 130}{885.4} = 2{,}450$ lb. of steam at 90-lb. pressure will be required. With the reduced and slightly superheated lower-pressure steam, the 64 B.t.u., must be added to the latent heat and $\frac{2{,}000 \times 8.345 \times 130}{949.4}$ = 2,285 lb. of steam is required to heat the same amount of water, a saving of 165 lb. But as the tank is not insulated, part of this saving will be lost through radiation due to the somewhat longer heating period.

If, on the other hand, a thermostatic trap is used (which discharges condensate at a constant temperature regardless of pressure and holds the condensate in the heating coils until part of the heat of the liquid is absorbed, thus utilizing the same percentage of the total heat at either pressure), there can be no saving by using a reducing valve.

South Amboy, N. J. RAYMOND SEPTOR.

Waste-Heat Recovery from a 135-hp. Diesel

Answers to May Question 2

The Question

WE HAVE a 135-hp., 300-r.p.m., 4-cycle, solid-injection diesel engine supplying power for our flour and feed mill. Exhaust gas temperature is 400 deg., jacket water temperature 120 deg., and load is fairly steady. Can we utilize jacket water and exhaust gas heat, and, if so, how much waste heat can we expect to regain for use in our low-pressure steam heating system? What sort of equipment would be used?—H. M. V.

An Unattractive Proposition

SINCE H. M. V. did not supply any data as to number and size of cylinders and amount of fuel oil used, these will have to be assumed to compute the amount of steam which could possibly be generated by the exhaust gases of his unit.

Speed and capacity show that the unit probably has three cylinders of about 12-in. bore and 16-in. stroke. The exhaust temperature indicates that it operates at an average of about 50 per cent of rated capacity, or 67.5 bhp. At this load, the engine will consume about 0.45 lb. of fuel oil per bhp, or 30.4 lbs. per hr. The weight of the exhaust gases equals the weight of the fuel plus the weight of the air entering the cylinders. The weight of air per cu.ft. depends upon its temperature, which will be above that of the room as it is increased when striking the hot interior of the cylinders. It is assumed at 130 deg. F. As not all of the burnt gas escapes, clearance volume can safely be neglected in computing.

Volume V in cu.ft. per hr. is:

$$V = \frac{0.7854 \times D^2}{144} \times \frac{L}{12} \times N \times \frac{\text{r.p.m.}}{2} \times 60$$

where D = diameter of cylinders, L = stroke, N = number of cylinders, r.p.m. = 300. Substituting these values gives:

$$V = \frac{0.7854 \times 12}{144} \times 12 \times \frac{16}{12} \times 3 \times \frac{300}{2} \times 60$$

$$= 28{,}270 \text{ cu.ft.}$$

The weight of this air will be:

$$W = \frac{PV}{RT}$$

where P is pressure in lb. per sq.ft., = 15 × 144 = 2,160, V = volume = 28,270, R = constant = 53.2, T = absolute temperature = 130+460=590. Substituting, we obtain

$$W = \frac{2160 \times 28{,}270}{53.2 \times 590} = 1945.5 \text{ lb.}$$

Total weight of exhaust gas = weight of fuel plus weight of air = 1945.5+30.4 =1976 lb.

Steam would be generated in a waste-heat boiler which the exhaust gases enter at 400 deg. F. and leave at a temperature at least 40 deg. F. higher than the temperature of the steam generated. The pressure of this steam is assumed at 5 lb. gage. Since the temperature at this pressure is 228 deg. F., the temperature of the leaving gases will be 228+40=268 deg. F.

Heat absorbed by the boiler from exhaust will be

$$H = W (t_1 - t_2) c$$

where W = weight of exhaust gases = 1,976, t_1 = 400 deg. F., t_2 = 268 deg. F., c = mean specific heat (assumed at 0.24). Substituting, we have Heat absorbed = 1,976 × 132 × 0.24 = 62,600 Btu.

As steam at 5 lb. gage has a heat content of 1,156 Btu., the heat required to change one pound of water at 120 deg. F. into steam at 5 lb. gage will be 1156 — (120 — 32) = 1,068 Btu, and the amount of steam generated will then be $\frac{62{,}600}{1{,}068}$ = 60 lb. per hour.

As the average cost of producing 1,000 lb. of steam is about 50c., 60 lbs. of steam will represent a saving of 3c. per hr. As the cost of a waste heat boiler completely installed and equipped will be in the vicinity of $1,500, it will take 50,000 hours of operation to pay for the installation—a very unattractive proposition.

Branford, Conn.

GEO. C. W. GOLEM,
Chief Engineer, Atlantic Wire Co.

Use an Economizer

TO UTILIZE exhaust gases, I would recommend installation of an economizer on the engine exhaust. The economizer is the same as a vertical boiler, in any desired diameter in proportion to horsepower of the unit. Exhaust of the engine connects to the bottom (or fire box) and a flanged hood on top, in order that pipe can be attached to extend the exhaust to the desired height.

Instead of low-pressure steam for heating, hot water can be used by installing a closed system, permitting the hot water to rise from the top connections of the economizers to the highest desired point. At this point, install an air trap in order that air pockets are removed, and permit circulation. From this height the hot water can be connected for distribution through overhead lines to radiators and return to the bottom of economizer. A supply tank can be installed a few feet above the highest point in the system and filled periodically if continuous supply with ample pressure is not available. This line is to be open continuously in order that the system is supplied with make-up to replace any small losses from leakage or hot water being drawn from system. Should heating system be needed when engine is not operating, a boiler can be located in the system in the same manner as the economizer and be fired to heat sufficiently to circulate the system water and not permit steaming.

We have economizers installed on gas engine exhausts ranging from 80 to 1,000 hp. that operate very satisfactorily.

Lancaster, Ohio. R. D. WEAVER,
Division Supt., Ohio Fuel Gas Co.

Will Serve 685 Sq.Ft. Radiation

THE GENERAL plan is apparently to evaporate a portion of the jacket water, at low pressure, in a heater through which the exhaust gases pass, and then use the low-pressure steam in a plant heating system. As an average, 28 per cent of the heat in the fuel supplied to a diesel engine is carried away by the exhaust gases. Assuming the 135-hp. engine is operating at full load and using approximately 0.40 lbs. per b. hp.-hr. of fuel oil which has a heat value of 18,000 B.t.u. per lb.; then the exhaust gases will carry 272,160 B.t.u. per hr. Of this amount, approximately 70 per cent may be recovered through the use of an exhaust gas heater, or 190,000 B.t.u. per hr.

Using the jacket water at 120 deg. F. as feed, and generating the steam at 5 lb. per sq. in. gage, 1,068 B.t.u. are required for evaporation of 1 lb. of water. The 190,000 B.t.u. per hr., which may be recovered from the exhaust gases, will then produce 178 lb. of steam per hr., for heating service. About 685 sq. ft. of equivalent direct radiation may be served.

Equipment required would consist of an exhaust gas heater with necessary accessories.

Bartlesville, Okla. CARL L. SIEGEL.

Two Questions for Our Readers

WHAT IS the best and least expensive method of cleaning an oil-soaked, brine-cooled cement basement floor? What treatment should I use to prevent this condition from occurring again?—A. W.

THE agitation air which we use in our ice-making plant is compressed to 28 lb. and then reduced to 15 lb. pressure before going to the agitators. To what temperature should this air be cooled in order to avoid trouble from condensation and freezing in the air lines to the ice tanks?—N. R. O.

Suitable answers from readers will be paid for if space is available for their publication.

Hot-Water System Would Be Better

A 135-HP., 4-cycle diesel will use about 54 lb. of fuel per hour. The amount of exhaust gas per pound of fuel burned will be about 25 lb. and the total weight of exhaust gas per hour 25 x 54 or 1,350 lb. By taking part of the jacket water at 120 deg., first putting it through a counter-current heat exchanger and then into an exhaust-gas boiler, steam at 212 deg. can be made and the exhaust gas temperature can be reduced approximately 200 deg. To heat a pound of water from 120 to 212 deg. requires 92 B.t.u. and to evaporate it at 212 deg. requires 970 B.t.u. or a total of 1,062 B.t.u. The heat exchanger will use 92÷1,062, or about 8.5 per cent of the exhaust heat. The reduction in temperature in the heat exchanger under these conditions will be 17 deg.

The temperatures will then be: Exhaust gases entering exhaust gas boiler, 400 deg., leaving 217; entering heat exchanger 217 deg., leaving 200; water entering heat exchanger 120 deg., leaving 212; entering boiler, 212 deg., steam leaving 212.

The logarithmic mean temperature difference for the heat exchanger will be 27 deg. and for the boiler 50.6 deg. A reasonable heat-transfer coefficient for both heat exchanger and boiler is about 6. Specific heat of the exhaust gas is about 0.25. Heat given up by the exhaust gas will then be (400—200) $0.25 \times 1{,}350 = 67{,}500$ B.t.u. 91.5 per cent of this heat is given up in the boiler and 8.5 per cent in the heat exchanger, or 61,700 B.t.u. and 5,800 B.t.u. respectively. The surface necessary in the heat exchanger will be:

$$5{,}800 \div (27 \times 6) = 35.8 \text{ sq. ft.,}$$

and the amount necessary in the boiler will be

$$61{,}700 \div (50.6 \times 6) = 203.0 \text{ sq. ft.}$$

In proportioning this surface, provision should be made for a fairly high velocity of exhaust gas, say 30 to 40 ft. per sec. About 10 per cent more heat could be obtained if the system could be adapted to use of hot water with a maximum water temperature of 180 deg.

Corvallis, Ore.

WALLACE H. MARTIN
Ore. State Ag. College.

Recover 120,000 B.t.u. per Hr.

IT WOULD be possible for H. M. V. to utilize a portion of the heat lost through the cooling water and exhaust gases. The amount depends upon a number of variables concerning which H. M. V. gives no information. The low exhaust temperature of 400 deg. for a 4-cycle engine would indicate the engine is only partially loaded or that much of the heat in the exhaust gases is absorbed by water-cooled exhaust piping between the engine and the point where the temperature was measured.

Assuming that the engine load is 75b. hp., the fuel consumption would probably be about 0.5 lb. per b. hp.-hr., or 40 lb. per hr. of 18,000-B.t.u.-per-lb. fuel. The heat released by combustion in the engine cylinders per hour, 40 x 18,000, or 720,000 B.t.u., would be divided approximately as follows:

Mechanical energy, 75 x 2,550 191,250 B.t.u. 26.5%.

Cooling water, radiation and friction losses 288,000 B.t.u. 40.0%

Exhaust gas losses 240,000 B.t.u. 33.5%.

With cooling water leaving the engine at 120 deg. and exhaust temperature of 400 deg., a total "heat head" of only 280 deg. is available for heating all or a portion of the cooling water with the heat in the exhaust gases. With a well designed waste heat reclaimer, probably 50 per cent of the available heat in the exhaust gases could be recovered or approximately 120,000 B.t.u. per hr.

El Reno, Nev. J. H. BENDER.

Keep Investment Down

IT HAS been my experience that utilizing waste heat from a small diesel does not pay for any expensive investment. I have seen several installations which were great dissapointments to the designers, and the reason is not hard to find. With a non-condensing steam engine, practically all of the heat in the steam passes into the exhaust; with the diesel, about one-third is useful work and some of the balance is dissipated by radiation, owing to its higher heat as compared to steam. In this case, a 135-hp. engine (at 80% load) would use about 5 gal. or 36 lb. of fuel oil per hour, which is equivalent to about 700,000 B.t.u. Assuming that two-thirds of this is rejected by the engine, we have about 470,000 B.t.u. This is equivalent to about 35 lb. of good coal or 40 lb. of ordinary screenings.

A better way in my opinion, would be to change to hot water heat, then the jacket water can be led through the exhaust in a coil and pumped directly to the heating system. Generating low-pressure steam will require an immense amount of surface to absorb the heat, for while the temperature of the waste gases may be high, the total heat per cubic foot is very low. Theoretically, with an economizer and forced draft, it is possible to bring exhaust gases down to atmospheric temperature, but I have never seen it done.

St. Louis, Mo. L. R. BAKER.

THE ENGINEER'S BOOKSHELF

Mine Power Plants

POWER PLANTS ON METAL MINES. *By F. A. W. Thomae, Associate, Royal School of Mines. Published by Mining Publications, Ltd., 724, Salisbury House, London E.C.2, England. 97 pages, 4¾x7¼ in. Clothboard covers. Indexed, and an appendix and bibliography. Price 5s.*

A concise assembly of data of design and actual performance of various types of power plants, representative of modern practice, comprises this volume. Planned for the mine manager, consulting engineer, student and mine plant engineer, it gives typical data on hydro-electric, steam, gas and diesel-engine plants in all mining districts of the world. A handy little volume, it avoids lengthy description, but gives all salient information.

Smoke

STOP THAT SMOKE *(1933). By Henry Obermeyer, assistant to the vice-president, Consolidated Gas Co. of N. Y. Published by Harper & Bros., 49 East 33rd St., New York, N. Y. 289 pages, 5x8 in. Clothboard covers. Indexed. Illustrated. Bibliography. Price $2.50.*

"One of the facts discovered by scientists who are studying city smoke disinterestedly has never been quite palatable to politicians. This is that the people themselves make most of the smoke . . . For every power plant or factory, there are thousands of individual home-operated heating systems, which, if we could see their combined smoke residue belching from a mere half-dozen chimneys, would make Vesuvius at her worst look like a small election bonfire. We have yet to learn that pollution is still pollution, even when it comes in small packages."

So Mr. Obermeyer sums up the home-heating plant smoke problem, which he says causes anywhere from one-tenth to five-sixths of the city smoke, depending upon the fuels used. America's smoke bill is $2,400,000,000 annually, of which $200,000,000 is fuel wastage alone. This is Mr. Obermeyer's thesis, and he develops it exceedingly well. He even explains fuels and firing and principles of furnace care, yet writes an intensely readable book. It handles the subject entirely from the popular angle and adds new emphasis to *Power's* editorial statements that it is better for the power plant to control its own smoke—or the municipality will.

Engineering English

THE ENGINEER'S MANUAL OF ENGLISH (1933). *By W. O. Sypherd and Sharon Brown. Published by Scott, Foresman & Co., 623 South Wabash Ave., Chicago, Ill. 515 pages, 4½x6½ in. Flexible covers. Indexed. Price $2.*

This business of English has always rather stuck in the practicing engineer's craw, for usually he can see no reason why he must be able to talk and write correctly if his work is good enough to speak for itself. His reasoning is true enough when only other engineers are considered, but the difficulty is that many and many an executive has had so little engineering experience that it takes fairly good English to give him even an inkling of what has been done.

It all comes around to the obvious fact that the engineer of today, no matter what his job, must know the fundamentals of English to write understandable letters, reports and analyses. This little book, by two authorities, will provide the background and will answer the questions that always arise.

Industrial Economics

MODERN INDUSTRIAL ORGANIZATION—AN ECONOMIC INTERPRETATION. *By Herbert Von Beckerath, translated by Robinson Newcomb and Franziska Krebs. Published (1933) by McGraw-Hill Book Company, 330 West 42nd Street, New York City. Cloth. 385 pages. Price $4.00.*

Professor Von Beckerath's book is not recommended as light summer reading. It is, rather, a solid and scholarly contribution to the literature of industrial economics.

The author writes from first-hand knowledge. For many years, prior to the War, he was an executive in a large enterprise, and during the War he held a (German) government post which had to do with industrial and trade association activity and organization.

The book deals primarily with the facilities of manufacturing operations as distinct from those of extraction and transportation. Attention is given to the machine age, the limitations of mass production and standardization, the rationale of advertising, a survey of the prospects of modern industrials, its relation to the nonmaterial side of life and its meaning for public ownership and socialism.

Steel Dictionary

IRON AND STEEL (THIRD EDITION). *By Hugh P. Tiemann. Published by the McGraw-Hill Book Co., 330 West 42d St., New York, N. Y. 590 pages, 4x6½ in. Flexible fabrikoid covers. Illustrated. Price $4.*

Every man connected in any way with iron and steel manufacture will find this book unique. It is *not* a description of the iron and steel making process or of iron and steel uses; it *is* actually a dictionary or pocket encyclopedia of the iron and steel industry and its allied industries and sciences. It brings together and translates the varied nomenclature of the steel mill, the laboratory and the office, and for the power engineer having to do with steel and its properties, it gives valuable and concise treatises on various phases and processes of the industry.

BRIEF REVIEWS

POCKET TABLES FOR CUBICS. *Written and published by David Katz, South Milwaukee, Wis. Price, 35 cents*—A theoretical method for solving cubic equations which not only enables one to obtain numerical answers quickly, without plotting and approximations, but enables one further to express the solution to any given cubic as a simple formula. This formula may then be entered into theoretical investigation and subjected to various algebraic operations without evaluating its specific value. Of use in flow of water problems in hydraulics, heat capacity of steam or other gases, etc.

TEN YEARS. *A record of progress and achievements of the Electricity Supply Commission of South Africa.*—A 62-page record including photographs and information on various stations and engineers. Copies from Electricity Supply Commission, P. O. Box 1091, Johannesburg, South Africa.

INDEX OF ECONOMIC REPORTS, 1933. *Published by Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York, N. Y. 80 pages, 5x8 in. Paper covers*—Lists titles of over 500 reports and articles on problems of business management published by the Bureau.

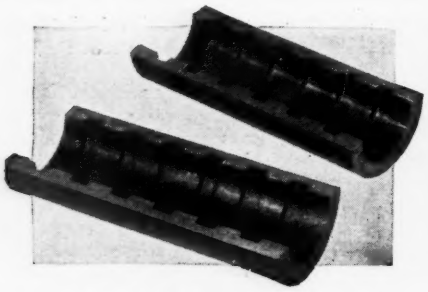
AN ECONOMIC STUDY OF THE USE OF CAMBRIDGE COAL WITH UNDERFEED STOKER EQUIPMENT. *By H. M. Faust, research engineer, Engineering Experiment Station, Ohio State University. 42 pages, 6x9 in. 25 illustrations. Published by Ohio State University as Bulletin 75 of the Engineering Experiment Station. Price, 25 cents*—Limited number of copies for free distribution.

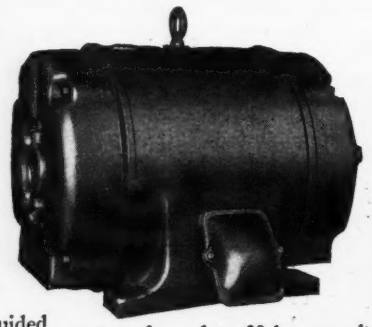
UEBER DEN SCHUBAUSGLEICH UND DIE BERECHAUNG DES AXIALSCHUBES BEI DAMPFTURBINEN (STEAM TURBINE AXIAL THRUST). *Edited by Dr.-Ing. Max Jobst Gercke*—Discussion in German of problems that arrive in connection with actual thrust balances, which is growing more important with the trend toward higher pressures and modern tendencies for developing the radial-flow type of turbine.

CHANGES IN PHYSICAL PRODUCTION, INDUSTRIAL PRODUCTIVITY AND MANUFACTURING COSTS, 1927-1932. *By Frederick C. Mills*—Bulletin 45 of National Bureau of Economic Research, 51 Madison Ave., New York, N. Y.

COMBATING CORROSION OF PIPING. *A paper by C. E. Joos and V. A. Rohlin, engineers of Cochrane Corp., Philadelphia. Copies available there*—Causes of corrosion, including acidity, oxygen in solution and electrolysis are explained, including hydrogen-ion concentration (or pH), and other factors discussed. Characteristics of water supplies and methods of eliminating oxygen solution in various arrangements of piping systems with deaërators are explained.

WHAT'S NEW IN PLANT EQUIPMENT





Molded Non-Metallic Bearings

Gatke bearings, formerly made exclusively for steel mill service, now for all general machinery uses. Composed of special textile base impregnated with synthetic resins, molded under high pressures and manufactured in all shapes and sizes. These bearings are molded of three basically different materials for various services; Gatke Hydrotex where bearings run in water, or where water is used for lubrication. Gatke Lubritex bearings for oil-lubricated equipment. Gatke Grafitex, self-lubricating, made especially for slow-moving machinery with dirt and grit. Replace any bearing or bushing. Can be molded to dimensions with inserts. No machining necessary. Low coefficient of friction; units not affected by ordinary acids, chemicals, solvents, salt water, or softened by oils or greases. Journal diameters from ⅛ to 24 in., and can be made to still larger sizes. High tensile and shearing strength, and high pressure resistance. One-seventh as heavy as bronze.

Gatke Corp., 228 N. La Salle St., Chicago, Ill.

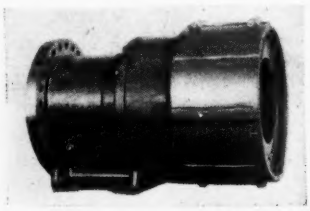
Safety Switch *(Photo at top)*

Type A quick make-quick break safety switches for severe duty are extremely compact. Nothing projects beyond box width, and cover swings vertically. Semi-floating, double-break V-blades, V-stationary contacts backed up with steel springs, individual barriers of arc-resisting asbestos, all mounted on single base which can be removed easily by taking out four screws.

The Electric Controller & Mfg. Co., 2696 E. 79th St., Cleveland, Ohio.

Expansion Joints for 400 Lb. Pressure

This line of slip expansion joints for 400-lb. pressure are of internally-externally guided type provided with specially designed anchor base. Chromium-plated steel slip is guided at both extreme ends. Greatest diameter of joint is only slightly larger than connecting



flanges. Internal guide consists of ring secured to body end of slip. This guide ring and inside of joint body are machined to close fit. This keeps slip free from joint body, consequently prevents moving metal contact with the polished surface of slip. External guide accomplished through hood, in two pieces for ease of removal. Two parts held accurately by a male and female bolted joint. Both parts also securely bolted to joint body with male and female joint. Flange on end of slip serves both as connecting flange and guide. Larger in diameter than standard flange and machined to fit inner surface of guide hood, which is also machined for entire distance of slip travel. Inward limit stop prevents slip from taking more than pre-determined traverse. Outward limit stop prevents pulling out of slip when pipe contracts.

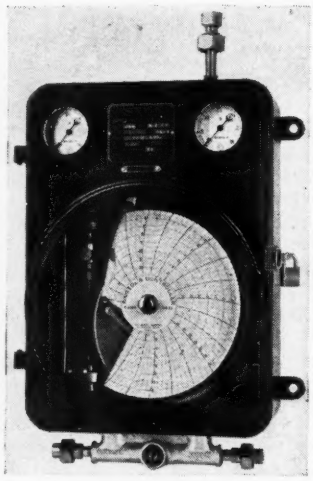
Joints are manufactured in all sizes in single- and double-slip type, with or without anchor base and with or without service connection. Pattern equipment so arranged that almost any traverse can be furnished. In addition to flanged type joint, either or both ends of joint can be furnished with beveled ends for welding.

American District Steam Co., North Tonawanda, N. Y.

Splash-Proof Motors

Primarily intended for splash-proof installations, this line of motors from 1 to 30 hp. may be used for outdoor installations as well. Frame and end brackets are of refined grey iron castings. One-way ventilation is provided by intake and outlet openings in lower section of end brackets. Bearing bracket fitted to frame by long-contact sealed fit. Cartridge-type, grease-lubricated ball bearings on all sizes.

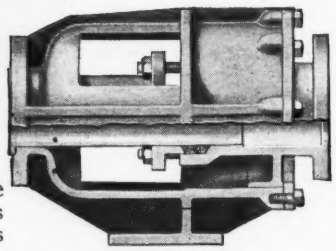
Century Electric Co., St. Louis, Mo.



Time-Temperature and Time-Pressure Controllers

In many processes, it is desired to regulate a temperature (or pressure) at some fixed rate, and then either hold it or decrease it at some other rate. These time-temperature and time-pressure controllers will do this, on any range of temperature from 40 to 1,000 deg. F., or pressure from 10 to 2,000 lb. Illustration shows Model 8040 MT controller, large cam type. Cam consists of graduated chart on sheet aluminum that may be cut by the user to give any desired control characteristics. Cam driven by either Bristol Telechron electric clock or by spring clock. Air supply and control gages mounted self-contained, and whole enclosed in compact moisture-proof aluminum case. Model 7240 MT is similar to other model, except that it is equipped with indicating pointer which shows instantaneous pressure or temperature at all times.

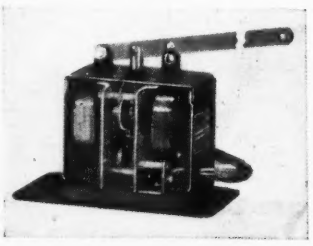
The Bristol Company, Waterbury, Conn.



Externally Guided Expansion Joint

This externally guided expansion joint differs from usual joint of this type in that sliding member is composed of stuffing box and guides; external guide being enclosed in cylinder extending full length of joint, and internal guide inside stuffing box and adjacent pipe section. External part is single casting, concentric with all sliding parts. Joint can be installed as shipped, since it is essentially integral and guides cannot be disturbed. External guide made relatively long, and distance from packing joint remains same under all conditions. Ample openings provided for repacking. Made with or without bases—bases machined when furnished. Single-slip joint shown. Also make double-slip joint of same design with base. All joints furnished in all sizes standard and extra heavy, or of cast steel.

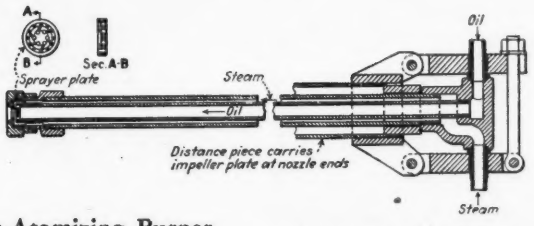
The Direct Separator Company, Inc., Syracuse, N. Y.



All-Electric Motor Power Unit

Type M94-1 "Modutrol" motor provides mechanical motion in proportion to demands of temperature of pressure controllers. Used for controlling air flow by positioning face, by-pass, fresh air, recirculating or mixing dampers or, when provided with suitable linkage, will modulate flow of gases or liquids through valves.

Minneapolis-Honeywell Regulator Co., 2702 Fourth Ave., South, Minneapolis, Minn.



Steam-Atomizing Burner

In order to handle fuels such as heavy oil, tar, pitch, and acid sludge, this steam-atomizing burner has been developed. Steam is admitted to annular space around central fuel barrel and is projected across each outgoing stream of fuel at nozzle plate, thus effecting complete atomization and resulting in short turbulent flame when used with the standard B & W burner register. Single nozzle plate is used for all capacities from maximum to minimum ratings, variations in capacity being accomplished by varying fuel and steam pressures.

The Babcock & Wilcox Company, 85 Liberty St., New York City.

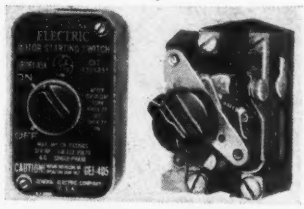
Indicating Flow Meter

Flow can be read accurately and inexpensively with this Foxboro Indicating differential gage. Gives continuous check on operating conditions and helps operator obtain closer regulation. Compact case and wide scale. Standard scale reads in per cent of total flow. Beneath graduated scale is white space on which reference notations of actual flow may be marked. If desired, instrument may be equipped with scale that gives direct readings of flow.

The Foxboro Company, Foxboro, Mass.

Starting Switch for Fractional-Horsepower Motors

Small, hand-operated starting switch, (CR 1061) for providing protection against stalled-rotor current and injurious overload conditions, has been developed for use with either single-phase a-c. or d-c. fractional-horsepower motors. A-C. switch available in single and double-pole forms. Switch affords following features: complete overload protection, positive snap-action mechanism trip-free on overload, compact construction and adaptability for mounting in purchasers' enclosures. All molded parts are Textolite and large contact tips are pure silver. Metal parts will resist corrosion. Switch tested and listed by Underwriters' Laboratories.



General Electric Co., Schenectady, N. Y.

Refractory-Protected Mercury Switch

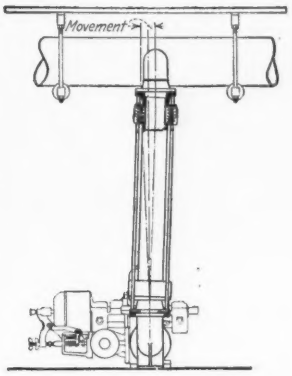
Nominal ratings from 3 to 50 amp., single-pole, single-throw, for either a.c. or d.c. circuits. Contact made by impact between two pools of mercury within refractory chamber encased in heavy glass walls.

Inert-gas atmosphere keeps mercury pure and dissipates heat of arc. Pools of mercury meet suddenly for sharp contact.

Westinghouse Lamp Co., Bloomfield, N. J.

Flexible-Disk Expansion Joint

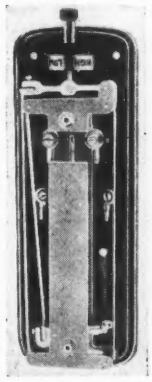
A new arrangement of "FlexoDisc" alloy steel expansion joint has been developed to meet individual needs of an industrial plant operating a large number of turbines. Due to number of steam connections, it was not practical to anchor either pressure steam header or exhaust header at points where connections were required. This meant shifting of headers at point of every connection where an anchor could not be provided for eliminating excessive strains on piping and turbine flanges. Strains were eliminated by arrangement shown, consisting of two short "Flexo-Disc" expansion elements connected by required length of pipe, and by tie rods, with take-up reaction due to steam pressure acting on bellows themselves. Bellows permit lateral movement with no strain on piping, and absorb expansion in interconnecting piping. Tie rods are fitted with swivel nuts so that they may also move freely as required. Design is useful for eliminating expansion strains where lateral movement, as well as linear expansion, must be handled without imposing any appreciable strain on piping, turbines or other equipment. Available for working pressures up to 300 lb. Expansion elements similar to standard joints.

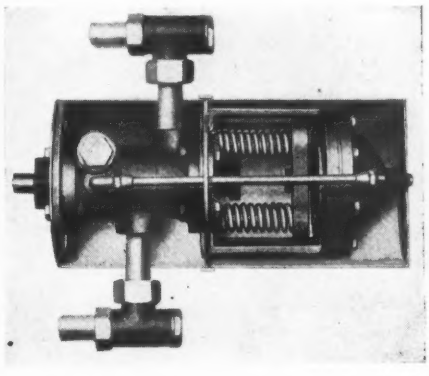


Croll-Reynolds Engineering Co., Inc., 17 John St., New York, N. Y.

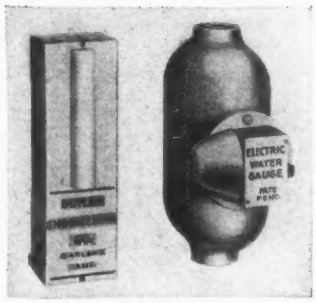
Open-Contact, Low-Voltage Humidity Control

New "Humitrol" designed for use with transformer on low-voltage air-conditioning systems up to 25 volts. Direct application can be made to equipment drawing 25 watts or less. Control humidity at any desired percentage up to 100. In-and-out operating range adjustable to 1 per cent differential. Calibrated at factory. Iridio-platinum contacts. Cover and base Bakelite, dark walnut. Over-all width 2⅞ in., length 7⅞ in., depth 1¾ in.





Lewis Air Conditioners, Inc., Minneapolis, Minn.



Electric Water Gage

"Bo-En-Co" electric water gage records electrically, at any desired point water level stage in steam boilers, pressure tanks or other containers. Indicator tube visible at 200 ft. Bell sounds at 3-in. change of level. Two parts to unit. Water column attaches to boiler and operates low-voltage relay switch which controls indicator. Indicator has lighted column in various colors.

Boiler Engrg. Co., Engineers Exchange Bldg., 715-19 Peralta St., Oakland, Calif.

Nickel-Clad Steel Sheets

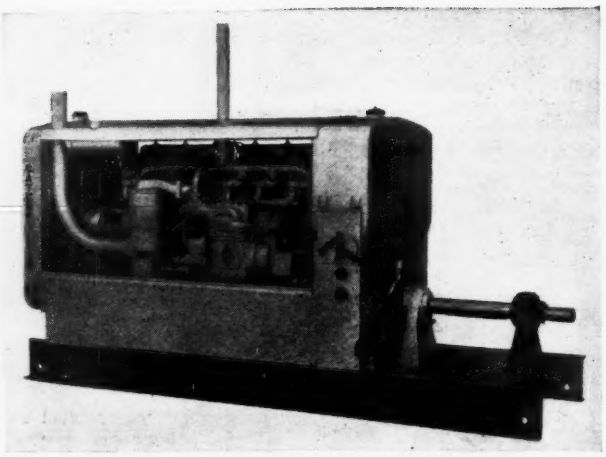
Nickel-clad steel sheets in thin gages hot-rolled (No. 16 up) or cold-rolled (No. 32 gage up) with bright and polished finish now available. Also furnish pure nickel-clad wire. Bulletin.

H. Boker & Co., Inc., 103 Duane St., New York City.

Fixed-Ratio Water Heater

"Hydro-Heater" delivers hot water at constant temperature and flow. Essentially two orifices—one for water, one for steam—in fixed ratio, metering both steam and water before thy mix. No thermostat required. No moving parts nor accessories. Three types, Type I for industrial use, Type C for continuous flow baths for hydro-therapy in hospitals, and Type S for shower baths. Cross-section of Type S unit shows construction. Two adjustments: one gives desired water flow, other proper steam flow to give desired temperature.

Hydro-Heater Corp., First Wisconsin Nat'l Bank Bldg., Milwaukee, Wis.



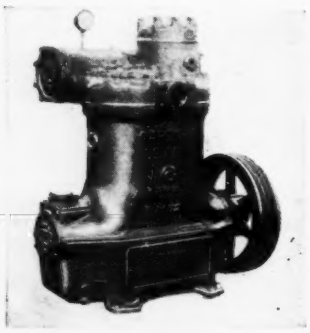
102-Hp. Portable Diesel Engine

"Caterpillar" D-11,000 develops 102 b.hp. max. at governed speed of 820 r.p.m. It is 144⅛ in. long, 66⅞ in. high, 47¾ in. wide and weighs 7,547 lb. Bore and stroke, 5¼x8 in. 7-bearing balanced crankshaft, force-feed lubrication to principal bearings, air cleaner, fuel filters. Positive starting by means of Bendix driven by auxiliary 2-cyl. gasoline engine shown.

Caterpillar Tractor Co., Peoria, Ill.

Duplex Vertical Two-Stage Compressor

This 3x2x2½ ADA duplex vertical two-stage compressor is used for air service and in modified form for engine starting, providing pressures as high



as 350 lb. maximum. Compressor has "finned"-type air-cooled intercooler, drop-forged crankshaft, and silent plate valves in both cylinders. Bulletin AC-6.

Gardner-Denver Co., Quincy, Ill.

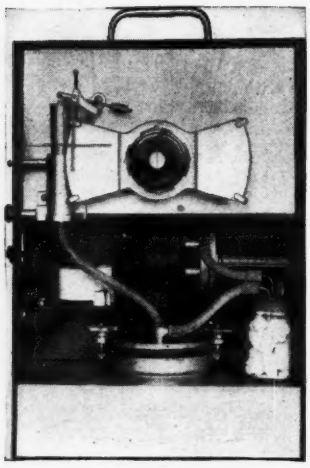
Pneumatic Transport System

No moving parts and no motor drives required in this pneumatic conveying system for pulverized coal and other fine materials. Power source is compressed air. System includes weighing tank automatically filled and emptied by air pressure. Tank mounted on springs on structural steel frame, allowing conical bottom to project into space between supports. Automatically operated discharge gate connected to bottom of discharge cone of container, and flexible hose connects discharge gate and suspended weighing tank and stationary discharge line. Automatic shut-off gate, air-operated, connects to source of feed, and air in weighing container is forced through transport line between loads, in order to clean out dust. Automatic closure gate built into top part of weighing container seals it during discharge. Movements of piston-operated filling gate and main air valve on top of the tank, as well as movement of the piston-operated discharge gate and vent gate at bottom of the container, controlled by pilot valve, which is in turn controlled by upward and downward movement of container as it is being emptied and filled. Pistons adjustable for timing.

Kennedy-Van Saun Mfg. & Eng. Corp., 2 Park Ave., New York, N. Y.

New Design CO_2 Recorder

Portable "Defender" CO_2 recorder illustrated has several improvements. Knurled thumbscrew at top of vertical pendulum weight to permit adjustment for calibration, to conform with Orsat tests. Bottom drain tube on water tank in which bell float works shown at left side of case. Overflow at top prevents too much water in tank. Rubber tube from bottom of bell float tank now placed in center of porous plate instead of from top of KOH tank. Small universal motor and rheostat now on detachable shelf on inside of case, and small portable Orsat for calibrating or testing recorder now placed on inside of case at back



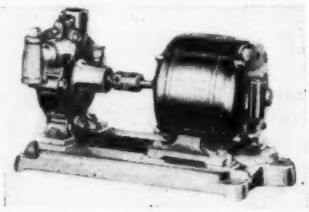
of clock plate. Rubber tubing, gas filter, and other materials and fittings necessary to operate instrument also packed in this compartment.

Two new bulletins describe 1-, 2- and 3-pen automatic CO_2 recorders. 8-page bulletin 9A illustrates self-contained and remote-type, motor-operated recorders and 4-page bulletin 9B illustrates the three models of portable CO_2 recorders.

Defender Automatic Regulator Co., St. Louis, Mo.

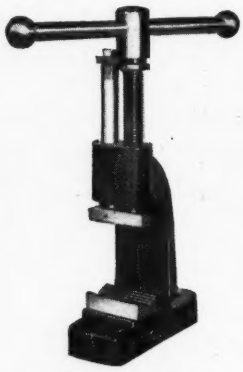
Regenerative Turbine Pumps

These pumps suitable for handling even small quantities of liquids efficiently at high heads. Capacities from 5 to 300 g.p.m. at heads up to 350 ft. Patented



taper-edge impeller permits varying quantity while pump is running. Slight increase in capacity as head falls, with noticeable decrease in power consumption. Impeller may be adjusted to give volume required at lower heads while taking advantage of savings in power consumed. Suction and discharge openings both located in main pump housing, thus facilitating disassembly without disturbing pipe connections.

Roots-Connersville-Wilbraham, Connersville, Ind.



Open-Side Pipe Vise

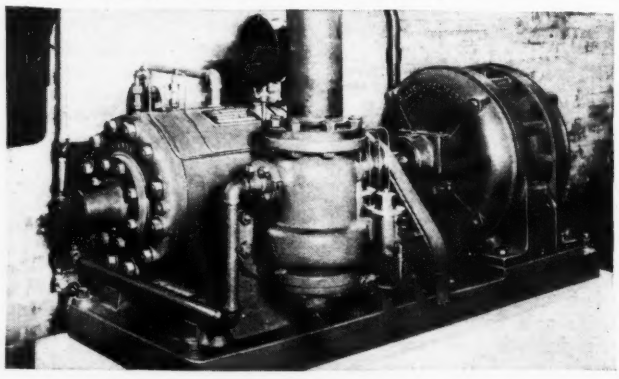
Toledo open-side pipe vises are made in three sizes, No. 00 (capacity ⅛ to 1½-in. pipe), No. 0 (⅛ to 2½-in. pipe), and No. 3 (⅛ to 4½-in. pipe). Heavy frame and long full over-lapping jaws of hardened tool steel. Easily replaceable. Handles over-size, permit easy jaw-setting and give greater leverage. Jaw construction permits working close to vise face.

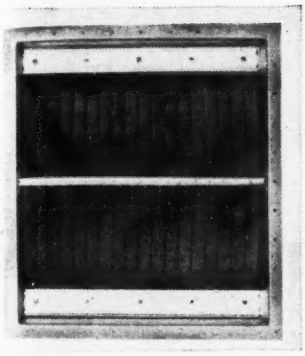
Toledo Pipe Threading Machine Co., Toledo, Ohio.

Single-Stage, Water-Cooled, Rotary Air Compressor

This complete line of rotary air compressors and vacuum pumps of multi-cellular, sliding-vane type, both water-cooled and air-cooled designs, covers range of volumes from 50 to 2,000 c.f.m., at pressures up to 150 lb., and vacuums up to 29.85 in. of mercury. Air-cooled units suitable for pressures up to 10 lb. gage, and vacuums up to 18 in. Hg. In water-cooled units for higher pressures and vacuums. Smooth operation, small dimensions, continuous delivery and absence of maintenance requirements are claimed. No belts or pulleys normally required, as units operate at standard motor speeds. Design simple, involving no valves or complicated motions. All working parts inclosed, but accessible.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.





Bent-Tube Heat-Exchanger Units

K-Fin Bentube heaters for air conditioning, cooling, heating and ventilating systems available in complete standard size sections suitable for general application. Use patented K-Fin tubing. Initially bowed tubes used accentuate curvature on increase of temperature. Each tube is free to expand and change its curvature independently of all others, without binding or interference. Units substantial but light. Distributed exclusively through Hitchen Engineering Co. Inc., 155 East 44th St., New York City.

Griscom Russell Co., 285 Madison Ave., New York, N. Y.

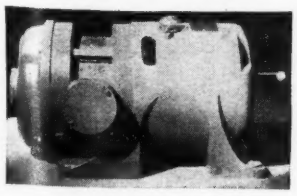
Furnace Glaze for Refractory Walls

"Fire-Kote" furnace glaze or vitrified coating for refractory walls does not contain silicate of soda, fuses progressively between 1,200 and 2,800 deg. F. and does not refuse or run at much higher temperatures. Will not check or flake off. Not affected by sudden changes of temperature and becomes integral part of surface to which applied. Seals baffles and air-cooled walls, prevents "freezing" of clinkers to furnace walls and will bind cracked or loosened fire brick.

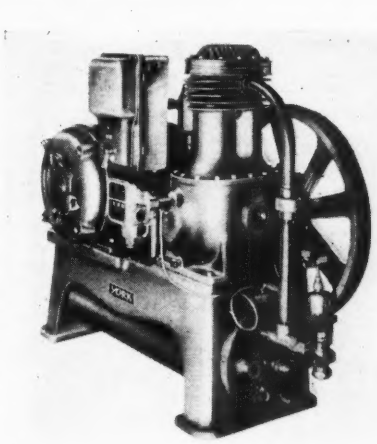
Mildon Engineering Co., Inc., 25 Broadway, New York City.

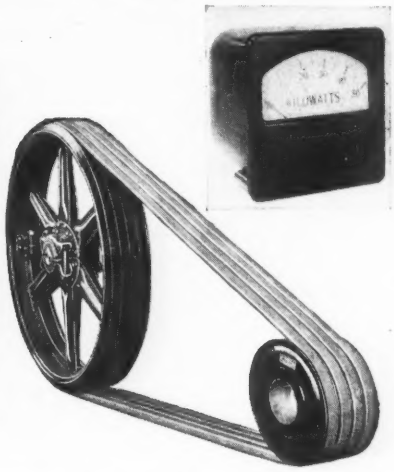
Gearmotors

Type S Reliance gearmotors are rated ¾ hp. and up, and combine motor and speed reducer in compact, self-contained, fully protected unit. Cartridge-type gear unit carries all gears and bearings, except high-speed pinion and bearing. Cartridge can be removed without disturbing gear or bearing alignment. Simple train of helical gears simplifies design and aids quiet running. Ratio can be changed readily by user by changing high-speed pinion and gear. Rotating cartridge gear unit provides 4 to 8 positions of output shaft. Oil height checked by bayonet-type oil gage. Unit supplied for wide range of ratios with both a.c. and d.c. motors.



Reliance Electric & Engineering Co., 1042-109 Ivanhoe Road, Cleveland, Ohio.





Electric Refrigerating Compressors

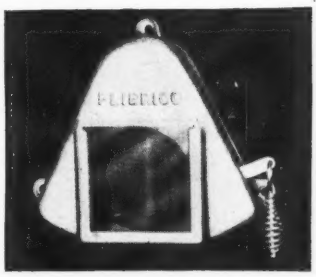
Thirty types and sizes of Freon electric refrigerating compressors, from ¼ to 20 hp., are included in this line. Greater refrigerating capacity per kw. input is claimed because of reduction in friction and consequent increase in efficiency, specially machined wearing surfaces of nickel iron, packingless crankshaft sealing mechanism, and Swedish steel valves.

York Ice Machinery Corp., York, Pa.

Controllers for Synchronous Motors

All standard lines of G.E. synchronous-motor control havebeen superseded by new. Included are relays for automatically applying and removing field excitation, and for protecting stator and amortisseur windings under all operating conditions. For automatically applying field excitation when motor reaches predetermined speed near synchronism, new slip-frequency field-application relay is provided. Coil of this relay is connected across a section of field discharge resistor with half-wave copper-oxide rectifier in series. During starting, induced field current of slip-frequency flows through discharge resistor so that half-waves of slip-frequency current flow through relay coil to cause it to open its normally closed contacts. When motor reaches predetermined speed near synchronism, the time interval between half-waves of current is sufficient to allow relay to drop out and apply field. Field can be applied at any predetermined speed from 92 to 99 per cent of synchronism. Unit also provided with power-factor field removal relay, which automatically removes field excitation when motor drops out of synchronism. Temperature relays are provided to protect stator, and amortisseur windings under all operating conditions. A Telechron motor-operated timing relay initiates transfer from starting to running connections on reduced-voltage and part-winding controllers.

General Electric Co., Schenectady, N. Y.



Observation Port

Inexpensive observation port for observing furnace conditions in boilers and other types of furnaces. Provided with divided cover which opens easily and closes automatically. Impossible to leave port uncovered. Overlapping sections of cover close tight. Port also equipped with blue Pyrex glass to protect eyes of operator from possible injury.

Plibrico Jointless Firebrick Co., Chicago, Ill.

Square Switchboard Instruments

Type K instruments are rectangular flush mounted, and are supplied with illumination. New method of attaching front cover eliminates all screws from front plate. Occupied panel area, 4 in. wide by 4¼ in. high. Mounting details worked out to permit mounting instruments in close grouping on 4-in. vertical center lines. Scale length, 3½ in. One square foot of panel space will hold nine instruments. Units available in volts, amperes, watts, power factor, frequency, reactive volt amperes, and radio frequency amperes.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Large-Diameter Steel Pulley

Wedgbelt pulleys of pressed steel in larger diameters have been added to line. Utilize American hub and arm construction with steel grooves mounted upon pulley face.

American Pulley Co., Philadelphia, Pa.

Combination Instrument

Where such variables as temperature, pressure, flow, and liquid level have direct relation to one another, records of these related variables on one chart are easily compared. With one instrument, initial and upkeep costs are both lower. In addition it is possible with combination instruments to make more compact, less expensive gage boards. This instrument is for recording and controlling pressure, and recording flow. Pressure controlling mechanism of Stabilog type. Used in gas pressure regulation where flow measurement is essential and on steam lines and fuel gas lines where pressure reduction is important and metering essential. Instrument equally adaptable to pressure regulation and metering of liquids and is used on water lines, brine lines and similar services. Available in either flush-type or in surface-mounted case. Equipped with weatherproof door construction, and, if required, case may be built gas-tight and vented to operate on natural gas.

Foxboro Co., Foxboro, Mass.

POWER LINES

Stoker and Pulverizer Makers Join Hands with Boiler Manufacturers

Anticipating passage of the Industrial Recovery Act, the American Boiler Manufacturers' Association meeting at Sky Top, Pa., June 5-9, completed preliminary plans for cooperation with the government. A committee, headed by Owsley Brown, President of the Springfield Boiler Company, was appointed for this specific purpose.

Equally significant, the A.B.M.A. membership was extended to include members of parallel power equipment groups. At the meeting many members of the Stoker Manufacturers Association and the Pulverized Fuel Equipment Association joined hands with the boiler manufacturers for common action in the interest of their respective industries, and the public welfare.

Special groups were provided to enable the manufacturers of stokers and pulverized fuel equipment to maintain their facilities for specialized contact.

The Sky-Top meeting, perhaps the most significant in the history of the A.B.M.A., marked the return of old members to the fold and the addition of new members, both active and associate.

As now constituted, the A.B.M.A. represents more than 90 per cent of the producing capacity of the industries concerned and thus is fully competent to represent them in all dealings with the government.

This contact will be made through the new A.B.M.A. "Committee for the Industrial Recovery Act," constituted as follows:

Chairman, Owsley Brown, President of Springfield Boiler Co.; Vice-Chairman, A. C. Weigel, Manager, Boiler Division, Combustion Engineering Corp.; Charles E. Tudor, President of Tudor Boiler Mfg. Co.; A. G. Pratt, President of Babcock & Wilcox Co.; Walter F. Kennan, Jr., Foster Wheeler Corp.; Starr H. Barnum, Vice-President of the Bigelow Co.; R. B. Mildon, General Manager of Stoker Division of Westinghouse; A. W. Strong, President of Strong-Scott Manufacturing Company; H. H. Clemens, Erie City Iron Works. J. D. Andrew has been selected as manager, with offices at 253 Broadway, New York City.

This Sky-Top meeting, the 45th annual meeting of the A.B.M.A., was notable for its spirit of cooperation among the manufacturers present and the clearly expressed desire to achieve the government's objective of improved labor conditions. The attitude was well expressed by Chas. E. Tudor, who said, in his presidential address, "We must get ready to accept the new order of things that lies directly ahead of us. The old order has broken down. Until recently this might have been doubted, but it is surely evident now."

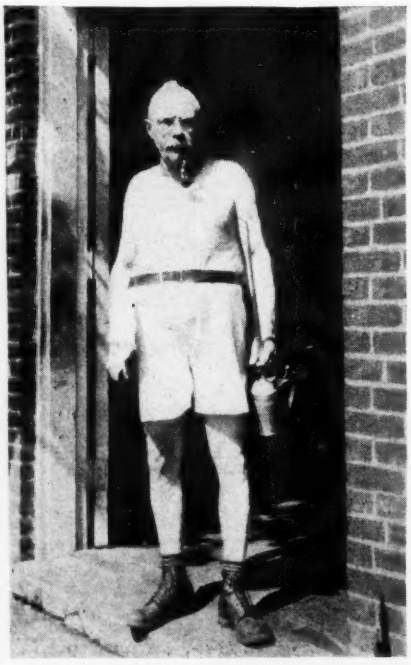
A feature of the meeting was the annual banquet, from which the following telegram was sent to Fred R. Low, honorary member, and Editor emeritus of *Power*: "The A.B.M.A. forty-fifth annual convention in session at Sky-Top Lodge sends best wishes and greetings to Honorary Member Fred R. Low and Mrs. Low."

Cove Creek Dam Plans Near Completion

Plans for the construction of Cove Creek dam will be completed by the Army Corps of Engineers July 20, but it will be 6 months or more before construction commences, according to Dr. Arthur E. Morgan, chairman of the Tennessee Valley Authority. S. M. Woodward, professor of hydraulic engineering at Iowa State University, is now at the district office of the Engineer Corps in St. Louis as the representative of the Tennessee board and will forward the plans, when completed, to Denver for review by J. L. Savage, chief designing engineer of the U. S. Reclamation Service. The first step, said Mr. Morgan, will be to build a highway and a railroad in to the dam site.

Prior to accepting the property at Muscle Shoals from the War Department, the Valley Authority will prepare a complete inventory. The new directorate also will take over on July 1 the payroll of 80 men now employed in nitrate plants No. 1 and 2 and the force of 280 now engaged in making the surveys at Cove Creek, and 30 more now in the Army district engineer's office at St. Louis. In order to inform himself of the actual status of affairs and expedite preparatory work as much as possible, Dr. Morgan and his associate on the board, Harcourt A. Morgan, will visit the eastern Tennessee district during the latter part of the week, returning to Washington a week or ten days later. Until its relationship to the federal government is definitely established the Authority will maintain its principal office in Washington.

Dr. Morgan stated that no consideration had been given by the board to building a transmission line from Muscle Shoals to Cove Creek as its policy on power development has not been defined. With reference to the generation of power, he said that he is in entire agreement with President Roosevelt that the projects to which the Authority commits itself should serve as a yardstick to indicate the feasibility and practicability of government ownership and operation. The Government's activity should, he said, be worked out by cases.



Air-Conditioned Engineer
Gus Schraplau, engineer at the U. S. Veterans Hospital at Whipple, Ariz., sends this photograph in with the explanation that outside temperatures run 98-99 deg., boiler room temperatures 115—so he discarded superfluous overalls. He also keeps an extra pair of shoes in the ice box, for a change when his feet get too hot.

Rising Power Loads May Swamp Capacity

Many power engineers, utility and industrial, are headed for early trouble at the present rate of load growth. Factories face increasing production schedules with run-down power plants and derelict "spare capacity." The utilities, to which they would naturally turn for power to tide them over a building period, are rapidly approaching 1929 load levels and may in some cases be forced to hold off additional industrial demands.

Exact figures are available for the U. S. utility load. Since the banking holiday its trend has been rapidly upward, passing the 1932 level on May 6, the 1931 level on July 1 and now within 2 or 3 per cent of the 1929 level. Total rise so far has been 20 per cent since March and the curve is still shooting steeply upward, in direct opposition to the normal summer slump.

This is the U. S. total. Certain sections, notably New England and some Southern states, are already above 1929 levels and threatening complete absorption of the ten per cent additional utility capacity installed since 1929.

Prime Mover Control Conference Held at Rockford

During four days, June 20 to 23, the Prime Mover Control Conference was held at the factory of the Woodward Governor Company, Rockford, Ill. Representatives of about 40 power and manufacturing companies attended. The sessions were devoted to governors for three types of prime movers, water wheels, steam turbines and diesel engines.

The work consisted of part-by-part building of governors. These parts were sectionalized to show the construction and to permit visualizing, in slow motion, the operation of each part and the timing relationship of the movement of all parts in the complete cycle of operation. Also, adjusting of governing equipment to accommodate the characteristics of a particular

installation; special adjustment of auxiliaries required in particular cases of unusual load conditions; permanent-magnet generator driving the governor heads and the resulting unit stability.

Work on automatic control of units included building up and operation of sectionalized parts to show the individual and correlated action of the various parts in the complete cycle of operation, which included self-synchronizing and pulling systems; automatic synchronizing systems and synchronous-condenser quick-loading emergency unit.

The last day of the conference was devoted to the relationship and advantages of the various prime movers to the system as a whole; recently analyzed system troubles and corrective measures applied.

Inspection trips to automatic hydro plants, steam-turbine generating stations and diesel-engine plants were also included as part of the conference work.

Arbitration Suggestions for Use With Industrial Recovery Act

To simplify the operation of certain provisions of the National Industrial Recovery Act, the American Arbitration Association, 521 Fifth Ave., New York City, has issued suggested provisions for arbitration in industrial codes laid down under such acts.

Water Used as Fuel

Now they're going to burn water as fuel, and without making smoke! This was the startling statement made by James McDonald, vice-president of Todd Combustion Equipment Co., New York City, at the latest monthly meeting of the Marine Smoke Association of Hudson County.

"By mixing oil and water, experiments we are now conducting show that the water can actually be burned as fuel at a saving of 17 per cent in oil consumption. There is absolutely no smoke."

The process has been patented. The mixture is 55 per cent oil to 45 per cent water. Heat efficiency is 83 to 85 per cent. Stack temperature is 100 deg. less than when burning straight oil.

New Diesel Plants in Japan

Three new diesel engine-generator plants in Japan have been reported by Mitsui & Co., New York City. The information was intended for the *Power* Table of Typical Diesel Installations, but was received too late for inclusion. The plants are: Niigata Electric Power Co., Niigata, Japan; one 1,600-hp., 150 r.p.m. engine furnished by Niigata Iron Works. Kyoto Electric Light Co., Kyoto, Japan; one 1,200-hp. Sulzer engine running at 167 r.p.m. Hachino-he, Aomori, Japan; one 1,025-hp., 215-r.p.m. S.L.M. engine.

News Notes

DR. JOHN B. WHITEHEAD, dean of the faculty of engineering, Johns Hopkins University, Baltimore, Md., has been elected president of the American Institute of Electrical Engineers for the year beginning Aug. 1. Other officers include: Vice-Presidents, A. M. Wilson, Cincinnati, Ohio; F. M. Craft, Atlanta, Ga.; R. B. Bonney, Denver, Colo.; R. W. Sorensen, Pasadena, Calif.; A. H. Hull, Toronto, Ont. Directors include P. B. Juhnke, Chicago, Ill.; Everett S. Lee, Schenectady, N. Y.; L. W. W. Morrow, New York, N. Y. National treasurer W. I. Slichter was re-elected.

T. R. LAWSON, head of the department of civil engineering, Rensselaer Polytechnic Institute, Troy, N. Y., has been elected president of the American Society for Testing Materials for 1933-1934. Official notice of his election was given on June 26 at the annual meeting in Chicago.

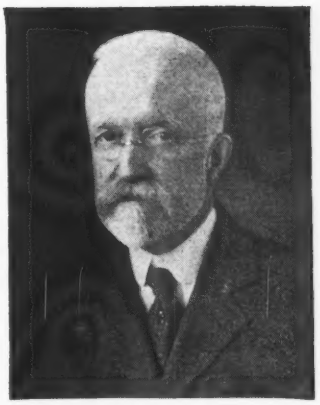
MALCOLM MUIR, associated with McGraw-Hill Publishing Co., publisher of *Power*, since 1905 and president since Oct. 30, 1928, has been appointed a deputy administrator for the National Recovery Administration by Gen. Hugh S. Johnson. Mr. Muir is past president of the Associated Business Papers (trade association of the business press) and was a member of the National Committee for Industrial Rehabilitation and chairman of its New York Board.

MRS. THOMAS CLARKSON, wife of the late inventor of the thimble-tube waste-heat boiler, visited this country for a week from June 19-24. She has been conducting her late husband's business, and in that capacity visited the works of Edge Moor Iron Co., American licensee.

HARRY REID & CO., INC., 84 William St., New York, N. Y., has been formed to engage in the operation, engineering and supervision of public utility companies. It is composed of Harry Reid, Edward C. Isele, David W. Jones, Alan E. Burns and Ralph C. Roe.

OBITUARIES

PROF. EDWARD F. MILLER, 67, for the past 22 years head of the mechanical-engineering department of the Massachusetts Institute of Technology, and a nationally known authority on steam engineering, died in Newton Center, Mass., June 12. He had been a teacher at the Institute since his graduation 47 years ago.

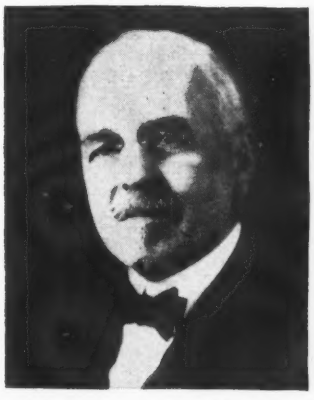


WILLIAM F. SELLERS, 77, former president of the Edge Moor Iron Co., and eldest son of the Wm. Sellers who founded both that company and Wm. Sellers & Co., machine tool builders, died June 14. He had worked his way up with the Edge Moor, beginning as a clerk in 1876, the year he graduated from college. He became president in 1905 and continued actively in that office until failing health gained the ascendancy in 1928. He took an active interest in the affairs of the company, however, until his retirement Feb. 1, 1933, when he was succeeded by Ely C. Hutchinson, former editor of *Power*. He was a member of the A.S.M.E., U. S. Chamber of Commerce, National Assn. of Manufacturers and several other associations.

DANIEL L. MCFEGGANS, president of the Mack Engineering & Supply Co., Inc., 136 Liberty St., New York City, passed away suddenly May 14.

CHARLES P. LENAHAN, 60, assistant superintendent of the New York Edison Co. power-house at 128-130 East 121st St., New York, N. Y., died in the plant recently from a heart attack.

JAMES A. SHEPARD, 60, vice-president of the Shepard Niles Crane & Hoist Corp., and widely known in engineering and industrial circles, died June 10 at his summer home at Kayutah Lake, N. Y. He established a foundry and machine shop in Montour Falls, N. Y., in 1880, in partner-



ship with his father and brother. This company was sold in 1903, and Mr. Shepard founded the General Pneumatic Tool Co., which later became Shepard Electric Crane & Hoist Co. Several years ago Shepard Co. purchased Sprague Electric Hoist Co. and the Niles Crane Co., and reorganized under its present name. Mr. Shepard was actively engaged with the company as vice-president and consulting engineer at the time of his death.

COMING MEETINGS

Nat'l Ass'n Power Engineers — National Convention, in conjunction with Niagara Frontier Power Conference & Mechanical Exposition, Buffalo, N. Y., Auditorium, Aug. 28-Sept. 2. Fred W. Rayen, Secretary 1140 Lake St., Oak Park, Ill.

A.S.M.E. Oil & Gas Power Div.—6th National conference, Ritz-Carlton Hotel, Atlantic City, N. J., Aug. 23-26. Louis R. Ford, chairman, 29 West 39th St., New York City.

Second American Exposition of Brewing Machinery, Materials & Products—Auditorium Hotel, Chicago, Ill., Sept. 23-Oct. 1, together with meeting of Master Brewers Ass'n of America. James R. Nicholson, 55 West 42d St., New York, N. Y., secretary. Felix Mendelsohn, managing director of exhibit.

American Welding Society—Annual Fall Meeting, Book-Cadillac Hotel, Detroit, Mich. Oct. 2-6. Details, A. W. S., 29 West 39th St., New York City.

Ass'n Iron & Steel Elec. Engrs.—Mechanical, Combustion, Lubrication, Electrical and Safety Divisions, 29th Convention & Iron & Steel Exposition, Wm. Penn Hotel, Pittsburgh, Pa., Oct. 17-19.

National Metal Congress—Fifteenth National Metal Congress and National Metal Exposition, Detroit, week of Oct. 2.

Sixteenth Annual Conference on Industrial Relations—Silver Bay on Lake George, N. Y., Aug. 23-26. Executive Secretary, E. C. Worman, 347 Madison Ave., New York.

Committee of Ten Meets

The second annual meeting of the Committee of Ten was held at the Drake Hotel, Chicago, Ill., June 15. This meeting was held in conjunction with the 14th Annual Convention of the National Coal Assn., which group opened a three-day meeting on the morning of June 15.

John C. Cosgrove, Johnstown, Pa., chairman, Technical Research Committee of the National Coal Association and president of the West Virginia Coal & Coke Co., was unanimously elected chairman for the ensuing year of the Committee. Mr. Cosgrove is official delegate to the Committee of Ten from the National Coal Association Other officers were all re-elected.

STRAWS

Pointing the way the business wind blows

York Ice Machinery Corp., York, Pa., has received additional orders for brewery refrigerating equipment, including one of $61,000 from the Interboro Beverage Corp., Brooklyn, N. Y. The Interboro order is for 2 large 4-cylinder ammonia compressors powered by 200-hp. and 150-hp. motors, 9 shell-and-tube 16-in. horizontal condensers 16½ ft. long, and 3 shell-and-tube 16-in. horizontal brine coolers 16 ft. long. Other orders just received are for a compressor and piping for Cleveland Home Brewing Co., Cleveland, Ohio; shell-and-tube condenser for Cold Spring Brewing Co., Lawrence, Mass.; and 2 large condensers for Kern Brewery, Port Huron, Mich. Brewery orders totaling in excess of $100,000 were announced by York Ice a few weeks ago. Since Dec. 1, the company has filled 42 orders for refrigerating equipment from 35 breweries.

Don Carlos Brewing Co. has been reorganized at Los Angeles, Calif., and capitalized at $1,500,000 by a syndicate of prominent men including Caryl Fleming as chairman of the board.

Santa Fe Brewery Co., 448 S. Hill St., Los Angeles, Calif., with capital of $1,000,000 and plans brewery plant and addition on Santa Fe Ave., between 15th and 16th Sts.

Florence, Ala., is voting on a proposal for municipal ownership of a power and light plant. $300,000 in bonds would have to be issued.

State Reconstruction Advisory Board, Salem, Ore., is considering a recommendation from State Board of Control for construction of power plant and refrigerating plant, in connection with new hospital unit at Oregon State Prison. Entire project is estimated to cost $290,000, with equipment.

The new municipal power plant planned at The Pinnacles, Patrick County, Va., hangs in the balance, depending upon a loan from the government of $2,500,000 and agreement of the citizenry. Plants in Danville, whose city council started the plan have refused to obligate themselves to buy municipal power, and some citizens object to the taking of responsibility of a large loan.

Dick & Bros. Quincy Brewery Co., Quincy, Ill., has authorized doubling annual capacity to 200,000 barrels.

Air-conditioning equipment to eliminate odors from refuse awaiting the city collector is an odd job but an installation of Westinghouse units for that purpose has been made in the Shoreham hotel, Washington, D. C. Contract for the equipment was placed with Wm. E. Kingswell, Inc.

Louisiana Brewery has been formed at Shreveport, La., and will build a brewery with daily capacity of 7,500 cases. Milton W. Smith, 341 Albany Ave., has asked for specifications and prices.

Los Angeles Brewing Co., Los Angeles, Calif., is planning to double its capacity to 600,000 barrels annually. Philip Zobelein is secretary-treasurer.

Pumps & Power Ltd., 40 East Cordova St., Vancouver, have been awarded contract for installation and supply of electrically driven power pumps in connection with the installation of further equipment in the new vegetable oil plant at Vancouver harbor. Pumps to be installed will have a capacity of 25,000 g.p.h. Vancouver Harbor Commissioners awarded the contract.

J. B. Meriam, president of the Meriam Co., Cleveland, reports a steady increase in business. Among engines recently shipped are, a direct-coupled gas-engine generator set, 110-hp., 3-phase, 2,300-volts, 60-cycle, for operating the lighting and power system of the Forrest Hotel, Hattiesburg, Miss.; one 60-hp. gas engine for driving an ice machine at Wood Ice Co., Bowling Green, Ohio; one 45-kva. gas-engine driven unit for Johnson Ice Co., Fremont, Ohio; one 50-hp. oil-engine driven set for Freedom Ice Co., Freedom, Pa.; and one 115-hp. gas-engine generator set, 100-kva., 3-phase, 60-cycle, 220-volt, for King Bee Milling Co., Alliance, Ohio. The company has also recently completed installation of a 100-kw. gas-engine generator unit at Fort Worth Macaroni Co., Fort Worth, Tex. The manometer and flow-meter division also reports a decided increase. Substantial orders have been received from one of the well-known oil companies. Another considerable order, from a large carbon-black manufacturing plant at Borger, Texas, includes 150 "clean-out" type manometer-flowmeters.

Great Lakes Pipe Line Co. has closed a contract with Iowa Electric Light & Power Co. for 4,750,000 kw.-hr. per year for three booster stations on its pipe line at Roland, Williamsburg, and Springdale, Ia., which are on property of the power company. In each case, 3,600-r.p.m. multistage centrifugal pumps are being installed, operating at 400-lb. and driven by 2,300-volt induction motors. Roland has two 125-hp. units, Springdale a 350-hp. unit and Williamsburg a 350-hp. unit.

Bordentown, N. J., has authorized surveys and estimates of cost for a municipal electric light and power plant. Charles B. Rodgers, former city councilman, is head of committee in charge.

Three large transformers which will eventually handle power generated at Boulder Dam, through the municipal transmission system, have been ordered by the City of Los Angeles from Westinghouse. The transformers will cost approximately $150,000 and will be rated at 20,000 kva. each. They will be manufactured at the Sharon Works of Westinghouse.

Amherst, Ohio, has secured authority of Supreme Court to construct and operate a municipal electric light and power plant. A fund of $100,000 was authorized a number of months ago for project, which has been delayed by court action; F. N. Straus, 2613 Queenstown Rd., Cleveland, Ohio, is engineer. Another Ohio Municipality, Oberlin, has also secured permission from the same tribunal to proceed with construction of a similar project, for which a fund of $250,000 has been arranged; R. Husselman, Hippodrome Bldg., Cleveland, is consulting engineer for this plant. Two other Ohio cities are planning municipal electric power stations, Eaton and Wapakoneta. The former is considering a report recently submitted by the Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer, for such a project, including electric distribution system. Wapakoneta proposes a fund of about $100,000 for its plant, and Council will vote on measure calling for bond issue at July meeting, when engineer will be selected to make surveys and plans.

Five electric-operated pumping plants will be constructed by the Imperial Inter-Cities Water District, El Centro, Calif., for new water supply system at Calexico, El Centro, Imperial, Brawley and other points in the Imperial Valley district. Bids will soon be asked for deep-well pumping units and auxiliary equipment, including self-registering meters, pipe lines, etc. Fund of $986,149 is being arranged for the project. Charles N. Perry, 732 North Heliotrope Drive, Los Angeles, Calif., is consulting engineer, in charge.

Chesapeake & Ohio Railway proposes to sell the Kanawha Canal to Appalachian Electric Power Co., which later plans construction of a hydro-electric plant at Lynchburg (Va.) dam. The purchase price is $125,000.

Platte Valley Reservoir Assn., Gothenburg, Neb., Harry L. Williams, head, recently referred to in these columns, has organized the Platte River Valley Irrigation & Power Assn. to carry out a hydro-electric power and irrigation project in the vicinity of Sutherland, Neb. Petition to organize has been filed with the State. C. Robert Fulton, Lincoln, Neb., will be engineer for the development, which will include a hydro-electric generating station on the North Platte River. A large reservoir will be constructed near the State Experimental Farm in this vicinity. Project will cost close to $4,500,000. Thomas Price, Lincoln, will be chairman of new association, and Mr. Williams president.

Abingdon, Va., plans early call for bids for a municipal electric light and power plant, and waterworks station, for which plans are being drawn by the J. B. McCrary Engineering Corp., Atlanta, Ga. A fund of $300,000 is being arranged.

A new boiler unit consisting of a 3,230-sq.ft. Union Iron Works boiler and a

motor-driven Westinghouse, single-retort, underfeed stoker has been purchased by the Baker Castor Oil Co., for the Bayonne, N. J., plant. The new unit replaces an old HRT hand-fired boiler.

J. G. Berger, consulting engineer of Newark, N. J., reports several power plant projects on which he is engaged. Silver Lining Laundry, Yonkers, N. Y., is putting in a new power plant, including a 140-kw., 220-volt, 3-phase, 60-cycle, Skinner Unaflow engine set and a Union 1,500-sq.ft. boiler. A 1,250-sq.ft. boiler already in the plant is being rebuilt. Both are to be fired by oil and to operate at 150 per cent rating. Alphons Custodis Chimney Construction Co. has received the contract for the new stack.

The second plant is that of Victor Laundry Service, Inc., West New York, N. J., which is putting in a Boltz heat exchanger in a concrete tank under the washroom floor in order to recover heat from wash water run-off. It is expected to pay for itself in 1½ to 2 years.

Perfect Laundry Co., Inc., Newark, N. J., is rebuilding the brickwork of two 1,500-sq.ft. boilers, changing them over to oil firing with Magna rotary type burners and will operate them at 150 per cent rating.

Prudential Laundry System, Inc., Newark, N. J., is putting in an old Skinner Univalve uniflow rated at 125 kw., 220 volts, 3-phase and 60-cycle. A double-throw switch provides utility standby, as it does in the Silver Lining Laundry.

The Fort Pitt Hotel and Service Building, Pittsburgh, Pa., has had an investigation made for improvements in the boiler and engine rooms, by Mr. Berger.

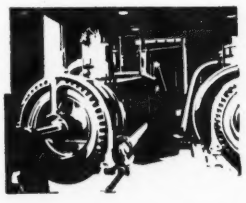
NEW MANUFACTURERS' BULLETINS

WATER COOLING EQUIPMENT — Binks Manufacturing Co., 3114-40 Carroll Ave., Chicago, Ill. 36-page catalog on water-cooling equipment, including spray cooling ponds in towers, deck cooling towers, spray louvre fencing, and spray nozzles for industrial applications.

FLEXIBLE COUPLINGS—F.A.B. Manufacturing Co., 67th & Vallejo Sts., Oakland, Calif. 8-page Bulletin No. 5; data on several types of couplings.

POWER PLANT EQUIPMENT—Vaughn-G. E. Witt Co., Emeryville, Oakland, Calif. 72-page Catalog No. 11; pressure-regulating valves for all purposes, gas-burning and oil-burning equipment, general power plant equipment, including valves and belting.

INSTRUMENTS—The Foxboro Co., Foxboro, Mass. 44-page bulletin, lists Foxboro sales and service offices, and indicates repair and replacement set-up.



BUILT-IN HEATERS—Commodore Heaters Corp., 11 West 42nd St., New York, N. Y. Notes No. 19; two sets of tables with five tables in each set, show performance of "Convectofin" heaters.

HEAT EXCHANGER—The Lummus Co., 50 Church St., New York, N. Y. 8-page Bulletin E-1, data and information on new high-pressure heat exchanger.

ELECTRICALLY OPERATED CONTROLLER—The Foxboro Co., Foxboro, Mass. 8-page Bulletin 184; electrically operated controller with rotating contacts for temperature, pressure, humidity and level. Lists power-plant applications.

FEED-WATER HEATERS — Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-210 S1, 4 pages, on deaerating type stationary feed-water heaters, and Bulletin No. 210 S2, 4 pages, on deaerating and metering type heaters. Other recent bulletins include 4-page W-318 S6 on three-stage volute centrifugal pumps for boiler feed, and 8-page W-321 S1C on Monobloc type with casing bolted to motor frame.

TEMPERATURE-CONTROL INSTRUMENTS — Mason-Neilan (Mason Regulator Co., 1190 Adams St., Boston, Mass., and Neilan Co., Ltd., 641-651 Santa Fe Ave., Los Angeles, Calif.) 32-page Bulletin No. 3000-C; Masoneilan compensated temperature-control instruments.

PIPING—Benjamin F. Shaw Co., Wilmington, Del. 4-page booklet, "Piping—Design, Fabrication, Erection," for power, process and heating purposes.

AIR COMPRESSORS—Ingersoll-Rand Co., 11 Broadway, New York, N. Y. 36-page bulletin; new two-stage, air-cooled portable compressor. Exceptionally complete in data.

PIPING—Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill. 8-page bulletin, "Designed Piping," flow test data and strength analysis on welded piping.

BOILER FEED-WATER TREATMENT—National Aluminate Corp., 6216 West 66th Place, Chicago, Ill. New Nalco AB System describes in 14-page illustrated booklet "A Scientific Boiler Water Treatment as Simple as A.B.C."

VENTILATORS—The Burt Manufacturing Co., Akron, Ohio. 6-page bulletin; ventilators of various types and louvres or fresh-air intakes previously described in *Power*.

HAND-TACHOMETER—Amthor Testing Instrument Co., Inc., 309 Johnson St., Brooklyn, N. Y. 2-page circular No. 106. New automatic fixed-reading tachometer for speed measurements.

AIR FILTERS—Coppus Engineering Corp., Worcester, Mass. 8-page Bulletin F-310-1; Annis air filters for air compressors and internal-combustion engines.

SHEET IRON — Republic Steel Corp., Youngstown, Ohio. Folder Form Adv. 114; complete data on various properties of Toncan copper-molybdenum iron.

BALANCING MACHINE—Tinius Olsen Testing Machine Co., 500 North 12th St., Philadelphia, Pa. Pages 21 to 26-C of Catalog "K," on Balancing Machine Equipment; latest Olsen-Lundgren Style "S" Dynamic Balancing-Machine Equipment.

AMMETERS—Columbia Electric Manufacturing Co., 1293 East 53rd St., Cleveland, Ohio. Two bulletins "Tong-Test Ammeters," for both d.c. and a.c. Also 4-page bulletin on 1- to 40-kva. a.c. generators for stationary and portable purposes.

VACUUM REFRIGERATION — Elliott Co., Jeanette, Pa. 4-page Bulletin G-4, "Refrigeration by Flash Evaporation Under Vacuum," steam jet ejectors, typical applications of suitable apparatus and control.

TURBINE DRIVE — Elliott Co., Jeannette, Pa. 4-page Bulletin H-8, "Mechanical Drive Turbines with Built-in Reduction Gearing," mechanical-drive turbines up to 100 h.p.

WESTINGHOUSE—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. 2-page leaflet on "Photo-Troller," light-sensitive control for operation on standard voltages. 16-page circular on switchboards, circuit breakers, gearing, temperature indicators and acid indicators, for brewery operation. Leaflet 20499 on combination linestarters for squirrel-cage and wound-rotor induction motors. 16-page circular 1924 on design and construction features of heat exchanger.

COMPRESSORS AND PUMPS—The Gardner-Denver Co., Quincy, Ill., Bulletin No. AA-6 (seventh edition), on Class "AA" Vertical Water-Cooled Compressors; Bulletin No. AC-6 (third edition), Air Cooled Compressors and Outfits; Bulletin No. P-36 (third edition) on High-Pressure Steam and Power Pumps, give specifications and typical applications.

GAS BURNERS—"Supremacy" a new 32-page booklet of Lee B. Mettler Co., 406 South Main St., Los Angeles, Calif., describes Mettler "Entrained Combustion" gas burners and applications.

GASKETS—Goetze Gasket & Packing Co., Inc., New Brunswick, N. J. A leaflet describes gaskets manufactured by that company.

STEAM TURBINES—Moore Steam Turbine Corp., Wellsville, N. Y., Bulletin, "Six Ways to Reduce Power Costs," lists six different applications of turbines for specific power and steam requirements and gives diagrammatic hook-ups.

REDUCTION GEARS—Poole Foundry & Machine Co., Woodberry, Baltimore, Md., Catalog No. 33-RG, describes single, double and triple herringbone gear units. Dimension sheet gives information pertinent to application of the units.

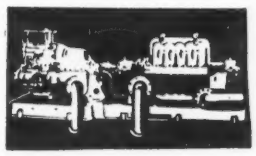
CENTRIFUGAL AND PLUNGER PUMPS—Worthington Pump & Machinery Corp., Harrison, N. J., seven bulletins: On Single-stage volute centrifugal pumps, Bulletin W-313-S1A, sizes 12 to 36 in. On horizontal pumps, Bulletin D-412-B2, forged fluid-end high-pressure pumps; Bulletin D-411-S1, Magma pumps for handling viscous materials; and Bulletin D-412-S5A, 2-in. stroke, 6 to 12 g.p.m. On vertical triplex pumps, Bulletin D-423-S12, automatic receiver sets fitted with multi V-drive, 1.6 to 39.2 g.p.m.; D-423-S12 on heavy-pressure pattern power pumps, 24 to 249 g.p.m.; D-423-S11 pumps for general and boiler-feed services, capacities 2 to 39 g.p.m.

DEEP-WELL TURBINE PUMPS—Bulletin No. 336 of Byron Jackson Co., Berkeley, Calif., on deep-well turbine pumps, gives sizes, capacities, and test results, and shows typical installations.

WELDING AND CUTTING EQUIPMENT — Smith Welding Equipment Corp., Minneapolis, Minn., 1933 catalog, 54 pages, describes line of welding and cutting equipment.

WELDED BOILER TUBES—Steel and Tubes, Inc., 224 East 131st St., Cleveland, Ohio, leaflet describes electric resistance-welded tubes.

CERAMIC INSULATING MATERIALS—American Lava Corp., Chattanooga, Tenn., folder on insulating materials of high dielectric strength and extreme heat-resisting qualities which are acid-resisting, non-corrosive, and possess good mechanical strength.



MOTOR SPEED-REDUCTION UNITS—Bulletin No. 1164, Allis-Chalmers Mfg. Co., Milwaukee, Wis., describes the company's motor-speed reduction units and gives ratings and speeds.

DESUPERHEATERS—Blaw-Knox Co., Pittsburgh, Pa., Bulletin No. 1417, describes and illustrates the company's line of desuperheaters.

COMBUSTION REGULATOR—Morey & Jones, Ltd., 922 South Hemlock St., Los Angeles, Calif., Bulletin No. 210 on new MJL-No. 27 regulator.

SPRAY COOLING TOWERS—The Marley Co., 1737 Walnut St., Kansas City, Mo., Bulletin No. 39, 14 pages, small spray-type cooling towers. Dimensions and specifications given.

RECORDING THERMOMETERS—Bulletin No. 169-1, 48 pages, Foxboro Co., Foxboro, Mass., contains valuable information on recording thermometers, their construction, operation and applications.

CONDENSER COOLING WATER—"Treatment of Condenser Cooling Water," new folder, Permutit Co., 440 Fourth Ave., New York, N. Y., discusses methods for reduction and elimination of scale in condensers, and points out resultant fuel economy.

INSULATION- AND GROUND-TESTING INSTRUMENTS—James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa., Bulletin No. 1355, lists and describes five different types and 40 ranges of "Megger" insulation-testing instruments and Bulletin No. 1360, gives similar information on ground-testing instruments.

MECHANICAL RUBBER GOODS—Diamond Rubber Co., Inc., Akron, O., new "Buyer's Guide to Mechanical Rubber Goods," a 24-page data book on most widely used mechanical rubber products including belts and listing standard stock sizes and list prices.

New Bulletins

TUBE CLEANERS—A. & H. Miller, Inc., 370 Lexington Ave., New York, N. Y., has issued a bulletin describing "Golden Crown Sectional and Layerbilt Wire Tube Cleaners for Ammonia Condensers" and another describing "Zimpa Cote Zinc Metallic Paint."

HEATING UNITS—General Electric Co., Schenectady, N. Y., has issued a 36-page bulletin on the company's electric heating units and devices.

FLOW INDICATORS—Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa., has issued Bulletin No. 6-F describing S&K rotameters and flow indicators for liquids and gases.

PHOTO-ELECTRIC RECORDER—General Electric Co., Schenectady, N. Y., has issued GEA-1480B to supersede GEA-1480A describing G-E photo-electric recorders.

FUEL ENGINEERING—"The Stream of Experience" is the title of a booklet commemorating the 25th anniversary of the Fuel Engineering Co. of New York, fuel and power engineers, at 116 E. 18th St.

STEAM TURBINES—General Electric Co., Schenectady, N. Y., has issued GEA-957C, superseding GEA-957B, describing two- and three-stage steam turbines for mechanical drive of 90 to 500 hp., Type D-53.

ANALYSIS OF METALS—"Increasing the Quantitative Accuracy of a Spectrometer" is the title of a pamphlet issued by Adam Hilger, Ltd., 98 King's Road, Camden Road, London, N.W. 1, England, describing the Insta eyepiece for the Spekker Steeloscope for metal examination.

WROUGHT IRON BILLETS—A. M. Byers Co., Pittsburgh, Pa., has issued a bulletin describing the company's genuine wrought iron forging billets for the manufacture of high-grade wrought iron of uniform quality.

HIGH-CHROMIUM CAST IRON—Electro Metallurgical Co., 30 E. 42nd St., New York, N. Y., has issued a bulletin describing high-chromium cast iron manufactured by the company.

COMPRESSORS — Sullivan Machinery Co., 400 N. Michigan Ave., Chicago, Ill. 8-page Bulletin No. 88-D; single-stage, angle-type compressors for low-pressure gas and air service, driven by direct-connected electric motor, diesel, belts, or steam-engine driven. 4-page Bulletin 88-I; 8-in. stroke angle compressors, 350 to 500 cu.ft. displacement, pressures up to 125 lb.

TESTING SET—Leeds & Northrup Co., Philadelphia, Pa. 4-page Bulletin No. 543. Type U testing set, a portable Wheatstone bridge designed for locating faults in communication cables and making a variety of other tests.

A.C. GENERATORS—General Electric Co., Schenectady, N. Y., has issued GEA-383D to supersede GEA-383C and describe low-speed a.c. generators of the 6000 series having welded-plate frame construction.

HYDRAULIC COUPLINGS—Hydraulic Coupling & Engineering Co., Ltd., Ceylon Works, Worton Road, Isleworth, Middlesex, England, has issued a series of bulletins describing Vulcan-Sinclair hydraulic couplings. These include pamphlets describing the scoop-tube type coupling for speed regulation of fans, another describing application of coupling to fans, pumps, flywheel generators, stokers and conveyors; another describing application of coupling to centrifugal boiler feed pumps; another describing coupling application as a slip regulator, and another describing the development of the "Fluid Flywheel" transmission.

STEAM AND POWER COSTS—"Calculating Steam and Power Costs in Industrial Plants" is the title of the latest edition to the data book sheets of Lefax, Inc., Philadelphia, Pa.

FORCED-DRAFT FANS—B. F. Sturtevant Co., Inc., Hyde Park, Boston, Mass., Catalog No. 391, 12 pages, on Rexvale forced-draft fans, including description, specifications and performance curves.

SPEED REDUCERS—D. O. James Manufacturing Co., 1120 West Monroe St., Chicago, Ill., Bulletin No. 11, 50 pages, right-angle spiral-bevel-gear speed reducers and gears. Gives specifications and ratings.

CENTRIFUGAL PUMPS—Centrifugal pumps, capacities 4,500 g.p.m., heads to 350 ft., described in Bulletin No. 203 Goulds Pumps, Inc., Seneca Falls, N. Y. Gives specifications and pump-selection chart.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Sheffield—City voted $150,000, municipal power plant.

Calif., El Centro—Imperial Inter-Cities Water Dist., applied to Reconstruction Finance Corp. for loan of $986,149 to develop water supply system, from wells and construct gravity supply line, including 5 deep well turbine pumps (310 ft. depth), 6 large self-registering meters, etc., to serve cities of Calexico, Heber, El Centro, Imperial, Brawley and Mexicali. Plans have been prepared by C. N. Perry, engr., 732 North Heliotrope Dr., Los Angeles.

Calif., Hayward—City provides $1,000 to make survey to determine estimates of cost of municipal power plant.

Calif., Los Banos—Municipality plans electric power plant. $28,000 or more.

Conn., East Lyme—East Lyme Water Co. plans water system extensions at Crescent Beach, Niantic, Pine Groves and Saunders Point and plant to consist of wells, pumping station, 6 and 8 in. water pipe, also 800,000 gal. standpipe. $100,000 loan granted by Reconstruction Finance Corp.

Ga., Atlanta — Emory University, H. Cox, pres., plans by Ivey & Crook, Candler Bldg., 1 story, 40x70 ft., rein.-con., brick boiler building, concrete pile found.

Ga., Valdosta—City plans application to P. Wks. Administrator for loan to finance construction of municipal power and light plant. $100,000-$150,000.

Idaho, Burley—Burley Irrigation Dist. plans expending $50,000 for enlarging pumping system at Minidoka Dam.

Ill., Edwardsville—City preliminary studies being made, sanitary sewerage system to link various parts of present system, sewage disposal plant, pumping station and drainage of several creeks in district. Plan to ask for loan under National Industrial Recovery Act.

Ill., Granite City—City Council preliminary surveys municipal light and power plant, $750,000; waterworks and distribution system, to exceed $1,000,000. Caldwell Eng. Co., Jacksonville, engrs.

Ill., O'Fallon—City Council retained W. A. Fuller Co., engrs., 2916 Shenandoah Ave., St. Louis, Mo., to conduct a survey for municipal light and power plant and distribution system.

Ind., Union City—City Council soon takes bids reconstructing waterworks, incl. rehabilitating well system, elecrtification of pumping station, installing elevated water storage tank, replacing existing wood mains with c.i. pipe. $45,000 Reconstruction Finance Corp. loan approved.

Ia., Frederika—Municipality plans municipal electric light and power plant. $50,000.

Kan., Burlington — City voted $118,000 municipal light plant, incl. $85,000 for engine and $33,000 for distribution system. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Ky., Catlettsburg — Municipality plans electric power plant. To exceed $40,000.

Mich., Elberta—Village retained Francis Eng. Co., engrs., Saginaw, to prepare plans and estimates for proposed waterworks system to include pumping station, reservoir or tank and mains. $25,000. Plans application to Reconstruction Finance Corp. for loan.

Mich., Sheboygan—City plans prepared for waterworks improvements and additions to include 2 pumps with combined capacity of 1,250 g.p.m., one 450 gal. deep well turbine, one 800 gal. turbine for well No. 3; direct connection to storage tank; structures for wells, standby unit; piping, valves and specials; also for generating plant with diesel engine, generators and exciters, street lights and distribution system; lights and current regulators. Total est. of lighting plant and equipment $22,700. Francis Eng. Co., 204 Eddy Bldg., Saginaw, engrs. F. Malenfant, city clk.

Minn., Grand Rapids—City plans municipal heating plant. $70,000. Will ask government aid.

Mo., Fredericktown—City sketches municipal light and power plant, equipment, etc. $100,000. Contemplate loan through National Industrial Recovery Act.

Mo., Mexico—City Council plans municipal light and power plant and sewage disposal plant. $442,724 loan will be asked from Reconstruction Finance Corp.

Mo., Moberly—City plans municipal power and light building. $700,000. May ask Reconstruction Finance Corp. for loan.

Mo., Rolla—Gasconade River Power Co., 605 R. A. Long Bldg., Kansas City, plans hydro-electric plant, incl. 1,800 ft. dam, 130 ft. high, etc., across Gasconade River between Arlington and Jerome, Phelps Co. $15,000,000. D. A. Dean, 605 R. A. Long Bldg., Kansas City, consult. engr. Federal Power Comn. expected to act on application soon.

N. J., Bordentown—City is now conducting electric surveys to determine cost of electric power plant, incl. installation of 600 hp. Diesel engines, 3 phase generators, switch boards and general completed plant, involving 12 mi. pole transmission, transformers, house meters, etc. $75,000. C. Rodgers, 105 Mary St., has charge of survey.

N. J. Glen Rock — Bd. City Council, preliminary plans pumping station, intercepting sewer and water line relative to Ferndale Pumping Station. $25,000. F. M. Evans, 36 Beechwood Rd., Ridgewood, engr.

N. J., South Amboy—Bd. P. Wks., W. Disbrow, clk., City Hall, plans 1 story, steel, brick electric light plant. $25000 or more. **Maturity indefinite.** J. M. Conlogue, city engr.

O., Alliance—Municipality plans electric power plant. To exceed $28,500. Engineer and architect not appointed.

O., Cleveland—Euclid-Doan Power Co., S. Cowan, vice pres., 1977 East 105th St., plans completed 1 story, 42x60 ft., brick, steel, concrete addition, 1977 East 105th St. $30,000. R. A. Spengler, 4614 Prospect Ave., engr.

O., Cleveland—Cleveland Railway Co., A. C. Kennedy, purch. agt., Midland Bldg., plans 1 story, brick, steel, concrete electric substations. $60,000. L. D. Bale, c/o owner, engr.

O., Dayton—Dayton Rubber Mfg. Co., West Riverview Ave., plans brick, rein.-con. power house and equipment, West Riverview Ave. $100,000.

O., Piqua — City plans storm sewers and pumping equipment to handle storm runoff in Shawnee sub-division of city during high stages of Miami River when river flood gates are closed. $28,000. A. Schroeder, city engr.

O., Woodsfield — Municipality plans power plant. $28,500 or more.

Pa., Monaca—Boro plans improving and extending waterworks system to Monaca Heights and Colony Dists., involving installing 8 new driven wells, small pumping station, 150,000 gal. standpipe, 3.2 mi. c.i. distribution mains, 5,600 ft. sewer laterals. Reconstruction Finance Corp. granted $40,000 loan. G. F. Wilson, borough clk.

Pa., Pittsburgh—Carnegie Institute, Schenley Park, selected as designing engineer the Rust Eng. Co., chg. E. R. Cate, Koppers Bldg., to convert Carnegie Institute's boiler plant into central heating plant to serve institute building, Carnegie Library, Mellon Institute, Cathedral of Learning and Heinz Memorial Chapel. Extensive boiler plant extension, pipe tunnels, pipe lines, connecting buildings to be served to central plant. All in Schenley Park Dist. R. G. Ambrose, sup. Carnegie Institute, company engr.

Tex., Austin—City, c/o J. G. Morgan, mgr., contemplates under Federal P. Wks. programme, raw water pump house and pump, $60,000; installing screen house and intake tunnel for raw water at plant, $45,000; new high service pump at water plant, $15,000; constructing 6 m.g. settling basin as addition to present settling facilities, enlarging head-house and installing lime, unloading and feeding equipment at filter plant, $100,000; spray pond, $75,000; install 7,500 kw. turbo-generator and 10,000 sq.ft. surface condenser and auxiliaries, $275,000; repairs to power plant boiler settings, $15,000. Total $585,000. Also service building to power plant, $150,000.

Tex., San Angelo—City, c/o E. E. Lowrie, mayor, preliminary surveys, etc., municipal light plant, incl. complete equipment. $100,000.

Tex., Seguin—City plans waterworks, incl. distributing system, pumping unit, new water wheels for light and water system incl. lighting or power plant and waterworks. Est. $60,000.

Tex., Teague—City, c/o V. R. Smitham, Wichita, plans municipal power plant, incl. distribution system. $500,000. Bids for preliminary reports and surveys rejected. **Maturity in fall.** Montgomery & Ward, Wichita Falls, engrs.

Va., Abingdon—City having surveys made by J. B. McCrary Co., 22 Metta St., Atlanta, Ga., for water supply system and municipal light plant.

W. Va., Fayetteville—Town plans constructing dam in Wolf Creek, impounding 2,500,000 gal., constructing reservoir on hill back of city, pumping plant to force water there 1,500 ft. $45,000. Bonds will be issued to be sold to Reconstruction Finance Corp. J. E. Settle, Charleston, engr.

Wash., Walla Walla—State, Olympia, plans by G. M. Rasque, Spokane Savings Bank Bldg., Spokane, power plant for state prison. $40,000 or more.

Wis., Madison—Common Council plans additional pumping equipment, etc. $25,000. Engineer not appointed.

Ont., Kingston—Queens University, Dr. W. H. Fyfe, principal, plans re-equipping electrical engineering building, destroyed by fire. Loss $150,000. Stone walls still standing can be used. Interested in prices equipment.